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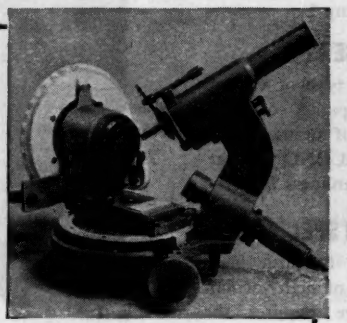

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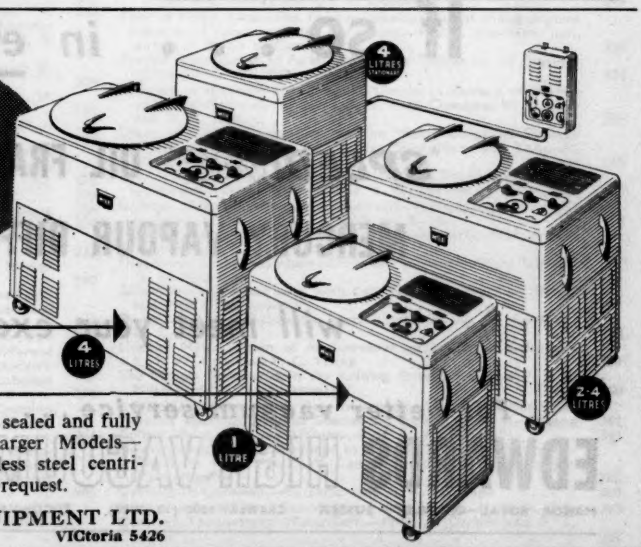

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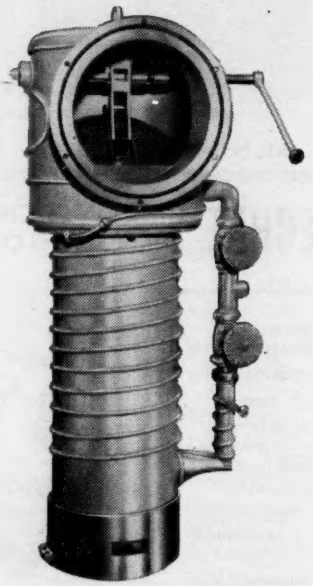

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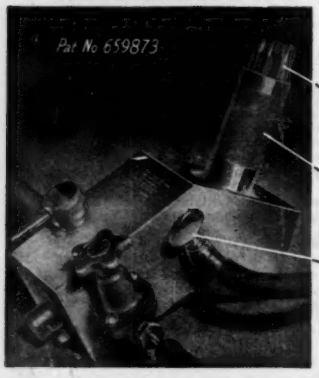

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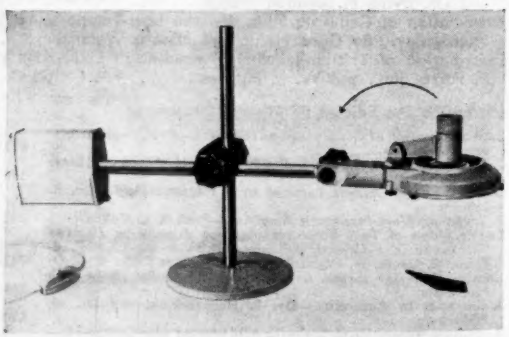

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BROADCASTING SERVICES AND EDUCATIONAL ACHIEVEMENTS

SOME three years ago, in March 1954, a Conference on Universities, Radio, Films and Television was sponsored by the Drama Department of the University of Bristol. In one of the papers contributed at this Conference, which were published for the University in 1956 (Butterworths Scientific Publications), Mr. E. Livesey, of the British Broadcasting Corporation, gave his definition of education: he suggested that it embraced the enlargement of horizons, the widening of experience and knowledge, both of the world outside the self and the nature of individual men, the awareness of the complexities of the world and of the human spirit, and through awareness the gradual acceptance of standards and ideals which have seemed to inspire the outstanding cultures and individuals both in the past and in the present. In short, it was in its effect on the uneducated section of the population that broadcasting had its greatest responsibilities and could make its greatest contributions. He also emphasized the great value in mass communication of the ability to interest a secondary audience as well as the primary one.

Mr. Livesey's remarks on the Third Programme audience, which he characterized as seekers and inquirers, as people with a certain attitude of mind or attitude to life rather than with a particular level of educational attainment, disposed of any idea of the Third Programme being a 'University on the Air', except perhaps in the sense in which the coffee-houses of the seventeenth and eighteenth centuries could be described as 'the penny universities', but he argued convincingly that the universities should take radio seriously. It was Dr. M. M. Lewis, director of the Institute of Education, University of Nottingham, who more specifically indicated the opportunities for the university, not simply in using mass media in its own internal teaching and in disseminating accurate knowledge about mass media and its relevance, but also in research. He stressed the importance of research on the conditions in which radio, cinema or television could become an effective medium, whether for the arts, as a means of communicating knowledge, or as an influence upon the attitudes of its audiences. He stressed also that it is important to ascertain if possible the relations between the components of each medium—the word as heard and the image as seen—and to understand the extent to which they reinforce or conflict with each other. Besides this almost entirely open field, there are the problems of the relations between these mass media and the written word, the effects of radio, film and television upon their audiences in the amount, quality and power of their reading.

It is even more apparent to-day than in 1954 that all this bears very closely, not simply upon education but also upon the whole fabric of public and social life. It may well provide, for example, the key to the social effects of equal opportunity to which Mr. W. James directed attention in a discussion at the Manchester Literary and Philosophical Society in March 1957. It bears equally on the problems of what may be described as cultural erosion, discussed by Mr. R. Hoggart in his book, "The Uses of Literacy", which have since found disturbing manifestations in other ways.

Perhaps the most disappointing feature of both the latest annual report of the British Broadcasting Corporation and of its Handbook for 1958* is that such problems are virtually ignored. The seriousness of such neglect is unmistakable to any thoughtful reader of Mr. Hoggart's book, as even his sub-title—"Aspects of Working-class Life with Special Reference to Publications and Entertainment"—might indicate. Writing with deep feeling and imaginative insight, Mr. Hoggart seeks to show that the under-educated in Britain—the three-quarters of the population whose schooling now ends at fifteen and whose distinguishing characteristic is rather lack of education than of money—are changing their traditional ways, and not for the better. Their freedom from poverty has exposed them to new and very deleterious influences, and while the gross prejudices and appetites are deliberately and even scientifically stimulated, the needs of the more serious-minded among them are neglected.

Mr. Hoggart achieves his purpose, and while he fails to offer much in the way of constructive suggestions and does not attempt to analyse the reasons why a minority resists this cultural erosion or to draw the distinction between this minority and the majority, both in its detail and in its comments his book displays the dangers in the present trends. It affords powerful support to Mr. Livesey's view that it is in the lesser educated section of the population that broadcasting has its greatest opportunities and responsibilities, and inevitably it arouses fresh doubts about commercial broadcasting. Once again the vital issue of the linking of power and responsibility is raised, and the reader may well reflect on the far-reaching consequences of the disappearance of independent newspapers and weeklies which contributed so much to sustain the creative minority on whom Mr. Hoggart relies to discharge a new and more difficult task, namely, that of waking the many from the hypnosis of immature emotional satisfaction.

Mr. Hoggart's study indicates sufficiently how much the responsible and constructive use of television and sound broadcasting could do to avert the

* BBC Handbook, 1958. Pp. 288. (London: British Broadcasting Corporation, 1957.) 5s.

dangers to which abuse of the mass-media—including the popular Press—expose us. He indicates, too, how this under-educated section of the community is losing its leaders and those best able to resist these blandishments. The implications and dangers of that process are set forth more fully, however, by Mr. James in his paper in *Manchester Memoirs* (98, 51; 1956–57) entitled "Social Effects of Equal Opportunity". Pointing out that although opportunity is still not equal and that serious-minded parents supply to their children incentives which are denied by those whose relaxations are the 'pools' and television, Mr. James emphasizes that one of the principal purposes of an educational system is to discover ability and encourage it. Men have always risen easily through the ranks of society in Britain; but to-day the selective process, abetted by the eagerness of industry to attract recruits of brains and character, is separating talent more efficiently than ever and leaving the great mass of the people, the base of the social pyramid, bereft of their natural leaders as never before.

Mr. James suggests that the thinking of society is done in groups, some functional and artificial like a trade union or a clique of a social club, some natural and spontaneous like the company which meets in a particular bar parlour or golf course. These groups are not isolated but knit together through individuals, and opinion may flow easily from one to another. Just as Mr. Hoggart stresses the needs for individuals and groups to assert their individuality and to think and feel for themselves and not in the mass, so Mr. James suggests that for this system of many interrelated groups to function healthily, each group should be in its own way self-sufficient, throwing up leaders of a quality sufficient for the level of the group. A healthy group should be able of itself to supply all the human material necessary for a happy administration of the leisure time of its younger members.

An inescapable result of a selective system of education is a drawing off of all men and women with the intelligence that goes with natural leadership from the groups at the base of the social pyramid and their transfer to groups higher in the social scale. Accordingly, the more this draining-off of talent ministers to the competitive capacities of the nation as a whole by ensuring the widest reserves of managerial and technical skill for manufacturing industry, commerce and administration, the more important it becomes to deal with the social consequences involved. Mr. James mentions, for example, the starving of the trade unions of leadership of high quality, and the probability, now that most of those who do not climb out of their class lack the talent to do so, that the future trade union leader will be less able than his predecessor. Power will still remain with the elected man who has risen from the shop floor, and in consequence there may be difficult problems of authority, as always occurs when leadership and power are divorced from trained intelligence. Mr. James makes his point provocatively by suggesting that on the political side we might easily slip into a State-managed trade union system, and that on the social side a great extension of welfare work will be required. Be that as it may, it is obviously important that the fullest and wisest use should be made of such media as broadcasting and television to stimulate leadership and sound thinking.

For this to be done there must be clear ideas as to the functions and limits of broadcasting. It is here that the report of the Royal Commission on (Canadian) Broadcasting, which Sir George Barnes has well described as "a classic statement on broadcasting", more deeply thought out, better argued and more clearly expressed than any British or American document on the subject that he had read, is so valuable. The Commission assumes that the content of a country's broadcast programmes is important to it because they have entered into the lives of the people and changed them in ways that are often unobtrusive and unnoticed. Their influence will grow rather than diminish and we must adapt them to our use, accommodate them to our purpose and weave them into the fabric of our lives, so that on balance they are agencies for good and not for evil.

If radio and television are not to dull sensibilities by endless repetition of the commonplace and tawdry, or become dehumanizing forces, making all men and women conform in thought, action and aspiration to the lowest common denominator of their kind, the Commission is clear that there must be regulation not only of technical matters but also of programme content and station performance. It believes that there must be some externally enforced standards of public interest to strengthen the instincts of public service that many private broadcasters feel. While advertising has a value and place in the broadcasting system, it is a legitimate exercise of public control to see that a limit is placed on the results of commercial pressures.

The Commission, after a cogent analysis of the effects of mass advertising on broadcasting programmes, points out that if audience-rating rules supreme, broadcasters will allow programme-planning to sink to the most boringly uniform and low level, and the responsibility of the broadcaster to lead his audience by making available fresh entertainment and experiences will be lost. While recommending the retention of private broadcasting, it concludes that free enterprise has failed to do as much as it could do in original programme production and the development of Canadian talent, not because of a lack of freedom but because of a lack of boldness. Accordingly, the Canadian Broadcasting Corporation should remain; but it should have its task more clearly defined, should know the limits beyond which it is not expected to go and should have the means and the power to discharge that task within those limits.

Neither in Canada nor in Britain is there room for the confusion and hesitancy which seem to characterize the last annual report of the British Broadcasting Corporation. It is true that the report claims that the B.B.C.'s policy is based on the

conviction that sound radio has a vital part to play in an age of television broadcasting, and it is true also that if sound radio is to remain vigorous and useful, reappraisals are necessary from time to time to determine the proper shape and scope of the programmes. Nevertheless, in spite of the affirmation that the B.B.C. intends to remain firm in its purpose and mission to serve the cause of education and the arts, and also to serve the community as a whole, including the majorities and minorities which constitute the community, there are indications that audience-rating may affect unduly the balance and even the content of the programmes.

The report shows that in the current year the number of combined licences for receiving sound radio and television will for the first time equal the number of licences for sound alone; but it does not discuss the relation between existing expenditures on sound and television broadcasting, the cost of which (excluding the external services) in 1956–57 was £11·6 million and £9·1 million, respectively. The report observes that, apart from the effect of any continued rise in costs, it is doubtful whether the income in view is sufficient to maintain the present services and to introduce essential progress in television to meet competition—which is seen as a burden rather than a challenge. The present estimates include nothing for major new developments, and neither the report nor the handbook refers to the challenge presented by these new opportunities.

It is in this respect that the report and handbook must be criticized. No attempt is made to present the Corporation's financial needs as an investment which could yield rich dividends to the nation both in education and in public policy. It should be clear to even a casual reader of the Fowler Report on Canadian Broadcasting that the comparatively small sums required to enable the British Broadcasting Corporation to embark on the developments both in television and in broadcasting required to enable it to maintain its high standards and to use to the full its present opportunities could do much to offset the dangers of which Mr. James and Mr. Hoggart have warned us so clearly. It is even possible that a useful contribution could be made to technical education at trifling cost. As it stands at present, however, there appears to be real danger of declining standards as well as of missed opportunities. Clearly the British Broadcasting Corporation needs all the support as well as the stimulus which informed and percipient opinion can bring, if the very real dangers which attend the mass media of communication in the world of to-day are to be avoided. It is idle to think that Britain can achieve the standards in technical education, for example, which are so highly desirable, under the domination of an under-educated society. The greatly increased expenditure on technical and technological education will not be forthcoming or wisely applied without the guidance of a creative minority which can stimulate the changes in broadcasting and television and in other spheres of communication that could minimize or largely avert the danger.

FRANKLIN, THE NEWTONIAN

Franklin and Newton

An Enquiry into Speculative Newtonian Experimental Science and Franklin's Work in Electricity as an Example Thereof. By Prof. I. Bernard Cohen. (Memoirs of the American Philosophical Society, Vol. 43.) Pp. xxvi+657. (Philadelphia: American Philosophical Society, 1956.) 6 dollars.

THERE must be many to whom the title of this book will seem paradoxical. How can Franklin, who is usually remembered in science to-day as the inventor of the lightning rod, stand comparison with Newton?

In fact, of course, no simple comparison is intended, although the author takes the opportunity of contrasting the comparative neglect with which he feels Franklin's scientific work is treated by scientists to-day with the prestige which it enjoyed among his contemporaries and successors. Franklin was "the first person out of the nation" to be awarded the Copley Medal by the Royal Society, and on his election to the Society he was given special privileges in the matter of fees; in Parliament he was compared to "our Boyle" and "our Newton".

Franklin, a man without mathematical training, was in no position to master the forbiddingly mathematical "Principia". Newton's "Opticks", on the other hand, was more accessible, for its proofs are based on experiments. More significantly, it is not a well-rounded work like the "Principia"; Newton appended a list of 'Queries', to which he added as edition succeeded edition, and these 'Queries' showed the eighteenth century the directions in which the master's thoughts had been travelling and were at once an invitation to further research and indications of profitable lines of attack.

Prof. I. B. Cohen feels that modern students of Newton have tended to neglect the "Opticks" in favour of the "Principia", and that the immense influence of the former work has therefore been obscured. To do this is to take a one-sided view of Newtonian science, a side to which Franklin could not contribute. "It is, in fact, the purpose of this monograph to show that Franklin was a Newtonian scientist by displaying the many-sided character of Newtonian science in Franklin's day and by analyzing Franklin's own contributions to science in Newtonian terms" (p. 83). So, for example, "Franklin's outstanding contribution to the theory of electrical action lay precisely in his clear grasp of the value of Newton's speculative ideas and in his understanding of the importance of following the spirit rather than the letter of what Newton said" (p. 107).

The work is divided into four parts. In the first, the author comments on the history of science in general and introduces his two main characters with a discussion of their personalities and reputations. Part 2 deals with Newton's two principle works, and it includes a detailed discussion, which is further elaborated in an appendix, of his use of hypothesis. It is amusing to reflect on the importance which has been attached to Newton's dictum, *hypotheses non fingo*, in spite of the passages in the "Principia" clearly marked "hypothesis" and in spite of the many speculative hypotheses in the "Opticks".

Part 3 contains first a carefully documented account of various works of the early eighteenth century which were inspired by Newton's experimental philosophy and which Franklin is likely to have studied, and

then a general discussion of Franklin's own place in the current of Newtonian science. In the last and longest part we are given a detailed account of the investigations into electricity in the eighteenth century, in which Franklin played a central part, and the book ends with a bibliography of nearly fifty pages and an index.

In spite of the excellence of the individual sections of the work, which are written with the authority of one who already has many contributions in the field to his credit, it is doubtful whether the somewhat disjointed thesis is adequate for so massive a work. The author himself recognizes that individual readers may wish to study only parts of the book, and he provides a detailed table of contents expressly for their convenience. But in spite of this defect in the work as a whole, the full and careful treatment which the individual topics receive will earn for Prof. Cohen the gratitude of all whose interests lie in this field.

M. A. Hoskin

BRUNONIAN DOCTRINE IN MEXICO

El Brownismo en México

Un estudio critico, seguido de la primera edición de la version castellana que hizo en México hacia 1800, el Doctor Don Luis José Montaña, de los "Elementos de Medicina" del Dr. Juan Brown. (Cultura Mexicana, No. 14.) Pp. ii+311. (México: Imprenta Universitaria, 1956.) n.p.

Dr. J. J. IZQUIERDO, who is professor of physiology in the University of Mexico and a well-known historian of medicine, has edited the Spanish translation of John Brown's "Elementa Medicinae" (1780) from a manuscript written about 1800 by Luis José Montaña (1755–1820), one of the most distinguished pioneers of medical teaching in Mexico. As a preface to the translation, Dr. Izquierdo contributes an interesting essay entitled "El Brownismo en México", which is also the title of the book.

It is a little difficult to understand why the author, who has already performed such useful service by editing Montaña's commentary on the Hippocratic works under the title "El Hipocratismo en México" (1955), should now regard Brown's treatise as worthy of similar attention. The "Elementa Medicinae" is by no means a medical classic. It was never taken seriously in Great Britain, and almost every medical historian, whether in Britain or abroad, regards Brown as a figure for derision and not for praise. Nevertheless, although in his own day he was a mere charlatan in the eyes of most of his colleagues, Brown was highly esteemed by many of his students and patients, and was well known on the Continent, especially in Germany, where, at the University of Göttingen, a riot between the rival factions concerning his doctrine was quelled only by military force.

John Brown, a schoolmaster of Duns, Berwickshire, who turned his attention to medicine and was a graduate of St. Andrews and a student at Leyden, became a pupil and secretary in the house of the famous William Cullen of Edinburgh, and at a later stage the bitter opponent and rival of the patron to whom he owed so much. Brown has been fitly called the Paracelsus of Scotland, since he was regarded by some as a genius and by others as a complete charlatan. The 'system', to which he laid claim as his own although it dated from the time of Asclepiades, was ridiculous in its simplicity. In his view health, and even life itself, was a response to continuous stimulation by warmth, food, fresh air, etc. When the stimuli were withdrawn, death resulted. Disease was caused either by excess or by diminution of stimulation. Consequently there were only two kinds of diseases, the *sthenic*, caused by too much stimulation, and the *asthenic*, caused by two little, or by depressive factors. Treatment consisted of the use of sedatives (usually opium) for the former, and of stimulants (preferably alcohol) for the latter. Such a simple and easy scheme of medical practice could not fail to attract the attention of physicians of that time, many of whom were perplexed and bewildered by the complexities of iatro-physics and iatro-chemistry, the twin theories which viewed the human body as a machine or a test-tube, and which had been introduced in place of the age-long theory of the 'humours'. 'Brownism', demanding little study or thought, appealed strongly also to students who welcomed relief from the burden of examinations. But there was a redeeming feature of the new system. Perhaps Brown, in spite of all his failings and fallacies, did actually perform a useful service in directing attention to the importance of the biological, as opposed to the physico-chemical, aspect of medicine. His doctrine may have formed a bridge, however frail and slender, between the scholastic age and the age of medical science.

Accordingly, we need not be surprised to learn that Brownism exercised some beneficial influence upon medical education in Mexico, a progressive country which could lay claim to the first hospital (1523) and the first organized medical teaching (1580) in the American continent, as well as to the first medical journal of the western world (*Mercurio Volante*, 1772). It does seem strange that Brown's "Elementa Medicinae" was translated into Spanish only twenty years after it was written, while Harvey's "De Motu Cordis" appeared in a Spanish version only after a lapse of more than three hundred years (1936). The reason was that Brown's work, at the time of its appearance, seemed to offer an easy solution to nearly every problem in medical practice, whereas Harvey's treatise, though infinitely more significant, remained misunderstood and devoid of practical outcome for many years. It was, in fact, born far ahead of its time, whereas Brown's answer to a pressing need was eagerly grasped and widely applied as soon as it appeared.

Dr. Izquierdo has therefore been fully justified in adding this curious chapter to his former studies of the early progress of medical education in Mexico. We are too apt to forget that the early history of medicine in Latin America had important repercussions throughout the civilized world and that it is a subject well worthy of our attention. The present volume is a fitting sequel to the author's splendid work on "Montaña y los origines del movimiento social y cientifico de México", and a fine tribute to the ancient medical school. It also serves to remind us that the phenomenon of the 'Brunonian System', or as the writer calls it, 'Brownism', despite its absurd simplicity, helped to divert medical thought, in Mexico and elsewhere, away from the traditional and often sterile theories, and towards the beginnings of the scientific basis which lies at the root of all real progress in modern medicine.

Douglas Guthrie

REPRODUCTION IN FUNGI

The Physiology of Reproduction in Fungi

By Dr. Lilian E. Hawker. (Cambridge Monographs on Experimental Biology, No. 6.) Pp. vi+128. (Cambridge: At the University Press, 1957.) 15*s*. net.

METHODS of reproduction in fungi have both a general and a special interest—general, inasmuch as reproduction is fundamentally important to all organisms, and special, for the following reasons. As a group, the Fungi exhibit a remarkable variety of reproductive mechanisms, the overall effects of which are to ensure the dispersal of the species to fresh habitats and its survival over periods when growth is not possible. The factors which control reproduction are thus of considerable practical interest in the case of the many fungi which bring about disease in higher plants. They are also of special interest to the fungal systematist, because reproductive mechanisms form the main basis for fungal classification. Furthermore, a large proportion of fungi can be grown under standardized cultural conditions and, as compared with most other plants, they offer great conveniences in ease of handling, in inexpensiveness of apparatus required and in the speed with which the life-cycle of many of them can be completed. It is not surprising, therefore, that much physiological work, dealing with reproduction and other activities, has been carried out with fungi, and it is a safe guess that, in the future, many of the more fundamental studies of growth and reproduction in plants will be based upon the same material.

Dr. Hawker's compact monograph gives an up-to-date and critical digest of the literature bearing on the subject. After a short introduction, in which the main reproductive types are briefly described, there follows an account of the growth of spores and spore-bearing structures. This chapter is important, as it is only when the succession of developmental stages is worked out with some precision that one can pose the physiological questions that are involved. This comes out very clearly with the more complicated fruit bodies, for example, of Basidiomycetes—as in Corner's detailed studies—but it is equally certain that there is an elaborate succession, on a more microscopic scale, of stages in the development of the simplest kind of reproductive structure, such as an oidiospore. The physiological work proper is discussed in four main chapters, the last of which deals with the intricate and still controversial problem of sex in fungi. A short final chapter considers the sporing behaviour of a number of fungi in the field, as interpreted in the light of experimental work in the laboratory. A list of some 350 selected references closes the monograph.

As the author ruefully remarks more than once, the physiological study of fungal reproduction has as yet barely progressed beyond the empirical stage. It deals almost entirely with the effects of environment—temperature, light, *p*H, quantity and quality of food supply, etc.—on sporulation. There is much diversity, as between one fungus and another, in the precise effects produced by any one environmental factor and very few generalizations have as yet emerged. This is not surprising, for it is the conditions inside the mycelium, as produced by the external environment, that control the onset, the amount and the kind of sporulation. The story, as it is unravelled, will undoubtedly be a biochemical one, with sequences of enzymatically and hormonally controlled reactions. There is already good evidence of the functioning of sex hormones in some of the lower fungi.

Sexual reproduction in fungi differs, in one very important respect, from that in higher plants. In the latter the key problem is: Why do diploid nuclei, after an indefinitely long series of mitotic divisions, suddenly undergo a reduction division, thereby giving rise to the reproductive cells? With fungi, the problem is the converse: Why do haploid nuclei, after a like series of mitotic divisions, suddenly become associated in pairs which, sooner or later, fuse to form a diploid nucleus, which in turn immediately reduces to the haploid condition? Clearly, any progress in either of these fields will have repercussions in the other.

The great merit of this book is that, though short, it covers the ground and, in particular, indicates where the many gaps in our knowledge lie. Its value to the research worker in mycology is obvious, for there are research problems, of a more general or a more special kind, to be picked from almost every page.

W. BROWN

SOIL SCIENCE

The World of the Soil

By Sir E. John Russell. (The New Naturalist: a Survey of British Natural History.) Pp. xiv+237+26 plates. (London: William Collins (Sons) and Co., Ltd., 1957.) 25*s*. net.

THE "New Naturalist" has nearly fifty volumes to its credit in the ten years of its history. The excellent contributions made by these volumes in the various fields of science already constitute a tradition. The editors' choice of author for a book on soil science could scarcely have been more auspicious, for Sir John Russell is internationally known to agriculturalists and soil scientists as director of Rothamsted Experimental Station for thirty years and as author of "Soil Conditions and Plant Growth". This present volume will introduce him to a wider audience for whom study of the soil is an absorbing hobby.

The arrangement of the subject-matter recalls the separate departments of any soil research institute. Soil geology, soil physics and soil organic matter are briefly but adeptly handled in the opening chapters and are followed by a more lengthy treatment of soil microbiology and zoology. Chapters on soil fertility and soil survey complete the book. The whole is written so admirably that the impression gained is never of a vast catalogue of research but rather of a living story simply told. One-third of the book is devoted to the micro-flora and fauna, and here Sir John excels. A fascinating array of bacteria, fungi, mites, arthropods, nematodes as well as earthworms, slugs and snails are discussed. Since Darwin's study of the earthworm, published some seventy-five years ago, has recently been reprinted, the relevant pages of the book under review are particularly apposite, for we are treated to an authoritative appraisal of Darwin's experiments—one could almost wish for more. The mole, the pad-mark of which graces the dust cover, receives but short shrift from the author; yet

there are hill pastures which will never see the plough where the mole is an active soil-former.

To the gardener in search of do's and don'ts, the chapters on soil fertility are probably the most interesting. The development of the modern fertilizer industry saw the birth of Rothamsted. The progress towards modern balanced fertilizers tailored to specific crops is a tale which cannot be told too often. Organic cranks are summarily dealt with: compost returns to the soil only what it has taken from it—should any element be lacking, composting will only perpetuate the trouble.

The final chapters deal with soil classification and soil survey; the soil is discussed in relation to the landscape and consideration is given to the uses to which the land can be put. This has been successfully done for southern Britain, but little is said of that large part of northern Britain once heather moor and now, due to the herculean labours of the crofters who reclaimed it, fertile and pleasant agricultural land. Such is Auchallater Farm in Glen Cluny (Plate XXII, which has both these places misspelt).

There are few printer's errors. On p. 144 the reference p. 000 is not helpful; Table 7, p. 94, has some curious arithmetic. The photographic illustrations are excellent as is also the drawing of the nematode (facing p. 114), but that of the crustaceans (p. 124) is lamentable, and Figure 9 (p. 136) cannot be regarded as useful. Very occasionally, too, the author nods: neutrality is stated to be *p*H 7·2; the meaning of the paragraph at the bottom of p. 145 is obscure; on p. 209, bilberry is said to be associated with wetter bogs, whereas it is an indicator of drier conditions. Crowberry could be substituted.

Altogether this book is one of "New Naturalist's" best. As a record of achievement for those who share Sir John's calling, it is heartening reading. The book, however, is intended for the lay reader. Apart from occasional OH's, NH_2's and COOH's, all terms are defined in the text. There is no glossary and none is needed. The words of a former proposer of a vote of thanks to Sir John can be quoted here: "The lecturer 'as been hintelligent, but not too hintelligent for us".

P. C. DeKock

RED SEA FISHES

Fishes of the Red Sea and Southern Arabia

By Henry W. Fowler. Vol. 1: Branchiostomida to Polynemida. Pp. v+240. (Jerusalem: The Weizmann Science Press of Israel, 1956.) n.p.

THIS book and the two volumes expected to follow it will constitute the only compendious account of the fishes of the Red Sea since Klunzinger's of 1879. It is compiled, not by a man who has had special opportunities to study Red Sea fishes, but by a courteous, now very senior gentleman, who sits in a small upper room in the Academy of Sciences of Philadelphia, armed with a great facility in line drawing, a long experience and a very fine index to fish literature. The work is offered, not as a contribution to knowledge, but as a tool for those able to study the fauna.

As such we must be grateful for it, and ordinary standards of criticism should perhaps not be applied. Those who will approach the Red Sea fauna for the first time with this as their key should be warned, however, to use it very critically, and only for preliminary determinations. Many of the species extend over the whole Indo-Pacific area, and if Mr. Fowler had no Red Sea specimens at hand, nor a description of such to copy, he drew up a description from a specimen from perhaps Honolulu or the Philippines. He explicitly disclaims, therefore, any ability to contribute to the question of geographical variation or subspeciation.

The telegraphic style of the descriptions will probably be understood by readers whose first language is not English, but more care for punctuation would have helped here.

On nomenclature Mr. Fowler is pitiless. It seems regrettable that decisions made in such a careful work as that of Bigelow and Schroeder on the sharks and rays of the western North Atlantic should not have been taken as standard. They have carefully considered the arguments for and against the use of *Carcharhinus* for a large genus, the type of a family, of sharks. In the end, the decision had to be arbitrary, and in the interests of stability they gave it for *Carcharhinus*. So far as Mr. Fowler is concerned, this work was in vain. He uses *Galeolamna*.

It is significant that the work is published in Israel, largely in answer to the needs of the young scientists at work there. No doubt Mr. Fowler would join us in the hope that among them are some who will eventually put it out of date.

E. Trewavas

ADVANCES IN JUNGIAN PSYCHOLOGY

New Developments in Analytical Psychology

By Michael Fordham. Pp. xiv+214. (London: Routledge and Kegan Paul, Ltd., 1957.) 25*s*. net.

THIS book is by one of Jung's disciples and deals with the philosophy of his school. The author was a founder member of the Society of Analytical Psychology and is a Fellow in child psychiatry at the London Child Guidance Clinic.

No doubt enthusiastic Jungians will enjoy reading it but others will feel exasperated and frustrated by the loose thinking. For example, on p. 23 the author states, "Jung points out that the concept of conservation of energy is based on age-old archetypical forms and Pauli shows how Kepler's scientific discoveries are linked with symbolic doctrines of great antiquity". It is, of course, easy to do this sort of thing, and one can always find a myth to fill the bill, but there is not one iota of evidence to prove it. Again on p. 107 he states, "It is well known that children love fairy and folk tales and will concentrate on them for hours, demanding repetition of particular stories over and over again. This phenomenon can only be understood in terms of activity of archetypes within the psyche of the child". But this is untrue. It can be understood otherwise if we are willing to try. A child wants to hear a story re-told again and again either because it gives it pleasure or dispels anxiety, or both at once. We do not need to drag in hypothetical archetypes to explain it.

The author is best with his description of children's neuroses, as one might expect from his training, and in this field his work is more acceptable.

Clifford Allen

The Organization of British Central Government, 1914–1956

A Survey by a Study Group of the Royal Institute of Public Administration. Edited by D. N. Chester. Written by F. M. G. Willson. Pp. 458. (London: George Allen and Unwin, Ltd., 1957.) 32*s*. net.

THIS corporate work provides a detailed account of the structure of British Government and the changes which have occurred since the beginning of the First World War. After reviewing the general pattern, each of the major fields of Government is surveyed in turn: finance, trade and industry; law, justice and public order; social services; external affairs; defence; common services; and scientific research. For that last chapter alone the book is of great interest to the scientist. It brings together scattered information not easily available, some of it new or unfamiliar to most scientists, and provides a more penetrating survey of government scientific organization in the civilian field than is contained in the pamphlet issued under that title in 1951. It lifts the veil slightly on the work of the Committee of Civil Research and shows how much Lord Balfour did to establish the position of science in Government. The concluding chapters in the central co-ordination of Government and the handling of administrative change, besides providing a factual account of the present arrangements, including the way in which the Lord President of the Council came to assume major responsibility for the country's scientific effort, gives some first information about the Cabinet Machinery of Government Committee appointed in 1942.

The great value of these two chapters lies in the clear exposition of the various factors to be taken into account in determining the structure of Government, for example, in deciding on the number of ministries or the grouping of functions, and in doing so they indicate precisely what is involved in proposals to centralize or decentralize scientific activities, including research, among others. Essentially a work of reference, the book is provided with notes and a bibliography which will facilitate further inquiry in directions likely to throw more light on aspects of the organization of science in Government now being debated. The book is thoroughly up to date, recording, for example, the changes last April in responsibility for nuclear energy.

Organic Chemistry

Electronic Theory and Reaction Mechanism. By Rowland I. Reed and Dr. S. Horwood Tucker. Pp. viii+108. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1956.) 15*s*.

THE 'organic chemistry' of the title is restricted to those aspects of theory covered by the subtitle; there is no description of preparations and properties. The contents consist of nine chapters on the electronic theory and its application to organic reactions, and two on reaction mechanism. The chapters deal with: the atom, the origin of valence, acids and bases, atomic and molecular orbitals, intermolecular influence of atoms and groups on valency electrons, physical methods of measurement, physical evidence for conjugative electron shifts, interatomic distances, the hydrogen bond, reaction mechanism, and substitution reactions. The terminology and the theoretical contributions of Ingold and his school receive considerable notice. Mesomerism (resonance), hydrogen bonding and the other new theoretical developments which have extended and revolutionized our ideas on molecular structure are very clearly explained. The new knowledge leads to the formulation of helpful generalizations, affords a deeper understanding of reaction mechanism, and indicates a more logical classification of descriptive matter. To older chemists and university freshmen desirous of studying the application of the electronic theory to organic chemistry, this book is recommended.

G. FOWLES

Statistical Tables for Biological, Agricultural and Medical Research

By Prof. Sir Ronald A. Fisher and Dr. Frank Yates. Fifth edition, revised and enlarged. Pp. x+138. (Edinburgh and London: Oliver and Boyd, Ltd., 1957.) 24*s*. net.

STATISTICIANS are well served in the matter of tables. The two standard sets, of which this is one (*Biometrika* Tables being the other), are beautifully printed and, by current standards, remarkably cheap. They run to new editions sufficiently frequently for continual additions and improvements to be possible.

This fifth edition of Fisher and Yates follows its predecessor of 1953 in general design, but incorporates several new tables and some extensions of former ones. Most of the material concerns variate-transformations, new tables being provided for 'logit' and complementary 'loglog' transformations, and the table of angular transformations is enlarged. A new table for the application of the product-ratio method in linkage investigations in genetics is also supplied.

Science and Human Life

Successes and Limitations. By Prof. J. A. V. Butler. Pp. viii+163. (London and New York: Pergamon Press, Ltd., 1957.) 15*s*. net.

THERE are quite a number of books of a popular, or semi-popular, type dealing with the urgent problems of the day thrown up by the advance of science and the tensions inseparable from human life. Prof. Butler has produced a handy little volume, in line with the general run of such works: it is interesting enough, but one may ask for whom exactly is it intended. The two sections, "Science and the Individual" and "Science and Human Society", cover adequately the fields suggested by their titles. But they contain very little beyond what can be garnered from ordinary contemporary reading. This result is not the author's fault; science *qua* science in everyday affairs is not what many people are worrying about. The difficulty is 'why' rather than 'how'; and having regard to Prof. Butler's point—manifestly correct—that intrinsic intelligence, apart from training and opportunities, has not increased greatly through the ages, the main need is for deeper philosophical insight at the point at which science ends, and faith or revelation may be said to begin.

The list of suggested books for further study contains several of a decidedly advanced character. On balance, they will conduct the reader into regions of thought not specifically scientific in the narrow sense (under Chapter 7 there is a misprint: 'Kaffka' should be 'Koffka'). But this may be all to the good, and Prof. Butler will have provided a sound introduction.

F. I. G. RAWLINS

A NEW DEAL FOR AUSTRALIAN UNIVERSITIES

By Sir ERIC ASHBY

President and Vice-Chancellor, The Queen's University, Belfast;
formerly Chairman of the Professorial Board, University of Sydney

INTRODUCTION

ON November 28, 1957, the Prime Minister of Australia, Mr. Menzies, announced in the House of Representatives in Canberra that the Commonwealth Government proposed, subject to co-operation from the States, to raise Commonwealth expenditure on the State universities from about £6,000,000 in the triennium 1955–57 to £22,000,000 in the triennium 1958–60. This is support on a scale beyond the dreams of Australian academic men a few years ago. It represents an act of statesmanship on the part of the Commonwealth Government. More than this, it provides at long last an opportunity for Australia's intellectual development to keep pace with her dramatic political and economic development.

The circumstances which led up to this historic announcement are as follows. In Australia, education is a responsibility of the States, not the Commonwealth. After the War, the cost of higher education increased steeply in Australia, just as it did in Britain. The States increased their grants to the universities by 123 per cent (although their revenue increased by only 77 per cent); nevertheless, these increases were insufficient to meet the universities' needs. The Commonwealth had come to the financial help of the State universities during and after the War to enable them to give higher education to large numbers of ex-servicemen; and in 1950 Commonwealth help was stabilized in a formula whereby the Commonwealth gives to each State, for its universities, £1 for every £3 of revenue the universities receive from State grants and fees. The Commonwealth commitment is limited to a ceiling of grant in any one year. Capital grants for buildings and equipment have not normally been provided by the Commonwealth Government.

There have been signs for some time that this machinery would soon become quite inadequate to finance the universities of Australia. The urgent demand for graduates, the unprecedented pressure of young people wanting higher education, the frustration among academic men in many university departments, have together precipitated a situation which could be resolved only by a drastic review of the whole of Australian higher education. This review has now been published*. In December 1956 Mr. Menzies asked a Committee of five, under the leadership of the chairman of the University Grants Committee in Britain (Sir Keith Murray), to inquire into such matters as "the role of the university in the Australian community; the extension and co-ordination of university facilities; technological education at university level; and the financial needs of universities and appropriate means of providing for these needs". The other members of the Committee were Sir Ian Clunies Ross, formerly a professor in Sydney and now chairman of the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.); Sir Charles Morris, vice-chancellor of the University of Leeds and sometime chairman of the Committee of Vice-Chancellors and Principals; Mr. A. J. Reid, chancellor of the University of Western Australia and formerly head of the State Treasury; and Mr. J. C. Richards, assistant general manager of the Broken Hill Proprietary Co. (B.H.P.). The Committee worked for three months, and has produced what Mr. Menzies described in his speech as a "brilliant and provocative report".

* Report of the Committee on Australian Universities. (Commonwealth Government Printer, Canberra, Australia, 1957.)

SUMMARY OF THE REPORT

The Background

The report begins with a lucid and restrained chapter on the role of universities in the community. It then goes on to describe the economic and educational setting of Australian universities: a population of 10 million increasing at a rate of 2½ per cent per annum and likely to reach 12 million by 1967; capital investment at the level of some £1,500 million in a year; primary industries with an output of more than £1,000 million; and international responsibilities under the Colombo Plan, the South-East Asia Treaty Organization, and the South Pacific Commission. All these activities need to have behind them healthy and adequately financed universities. The need for teachers is so desperate that in one State bursaries are offered to children "at the tender age of eleven plus if their parents express an inclination for them to become school teachers". The shortage of graduates is not confined to scientists and technologists: there is an unsatisfied demand also for graduates in arts, law and medicine.

There is no lack of recruits for these occupations. The school population increased from 1·1 million in 1946 to 1·8 million in 1956; but there is a severe wastage of talent at secondary school level through early leaving. In 1954, only 9·4 per cent of seventeen-year-old children were receiving any sort of full-time education. Nevertheless, some of the universities are, on British standards, large. A list of them, with their 1957 enrolments, is given in Table 1.

In 1956 the total recurrent income of all the universities was about £11·78 million, of which 79·5 per cent was provided by State and Commonwealth grants and 15·6 per cent came from fees.

Table 1

University and foundation date	Enrolment, 1957*
Sydney (1850)	7,407
Melbourne (1853)	6,341
Adelaide (1874)	3,331
Tasmania (1890)	750
Queensland (1909)	3,519
Western Australia (1911)	1,661
Australian National University (1946)	67
N.S.W. University of Technology (1949)	4,288
New England (1954)	591
Canberra University College (1930)	216
Newcastle University College (1951)†	—

* The enrolments are full-course equivalents, calculated as follows: full-course student = 1, part-course student = ½, external student = ¼. Some full courses at the N.S.W. University of Technology are designed for part-time students. The gross enrolment for 1957 was 36,465.

† Enrolments included under New South Wales University of Technology, of which it is a branch.

Present State of the Universities

Some departments in the larger universities are in a state of chronic congestion. First-year classes of more than 1,000 are not uncommon, and failure-rates are alarmingly high. For example, 30 per cent of holders of Commonwealth scholarships (of which 11,536 were awarded in 1955) fail to graduate. It is commonly believed that students come to the universities inadequately prepared and not sufficiently mature to benefit from university teaching; and of course the size of elementary classes makes any tutorial tuition in the first year very difficult. It has been an Australian tradition to admit all qualified applicants to universities and not to exercise any machinery of selection. The Committee realized the great practical difficulties in the way of limiting entry or raising matriculation standards, and it recommends that Australian universities should equip themselves to deal with the increasing flood of students coming to them, rather than protect themselves against the flood by putting up barriers to entry.

The Committee commented adversely not only on the high failure rate (which it describes as a "national extravagance which can ill be afforded") but also on the very low ratio of honours to pass degrees and the very meagre development of postgraduate work. The pattern of a large undergraduate department is illustrated by the Department of History in the University of Sydney in 1956. History i had an enrolment of 768; History ii, 332; History iii, 119; and History iv (the honours year), 11; and for this total enrolment of more than 1,200 students there is a full-time academic staff of ten. Accommodation in many departments is "bursting at the seams". Halls of residence (most of which in Australian universities take the form of 'colleges' under church endowments, but which do not impose religious tests on their residents) are quite inadequate. This is particularly serious because of the considerable Asian student-population now to be found in Australian universities and because about half the population of Australia lives away from the big metropolitan centres. Academic staffs were reported by the Committee to be disheartened not only by enormous elementary classes and small honours schools, but also by other difficulties. Their salary scales were low by comparison with those of other professional men (the Prime Minister alleviated this difficulty by including in his announcement a substantial lift in salary-scales). The superannuation system does not allow of easy migration of staff between universities and C.S.I.R.O., or even between all universities. In most universities the staff have no adequate common room or meeting place. For years there has not been enough money for libraries, equipment and technical assistance; and the high cost of travel is an obstacle to the sort of inter-university conferences and meetings which would be a great stimulus to academic men.

Problems Ahead

To these old difficulties, which many academics have endured heroically and successfully overcome, formidable new difficulties will shortly be added. Numbers in the 15–19 year age-group actually fell between 1947 and 1952. They rose by 16·4 per cent during 1952–57. Between 1957 and 1962 they are expected to rise by 36·4 per cent. Enrolments in universities are expected to increase from 36,465 in 1957 to 70,785 in 1965. A first-year chemistry class, which to-day has an enrolment of 1,400, may in ten years time have to deal with an enrolment of 3,000. Sydney expects by 1965 to have a student population of 27,000 (17,000 in the University of Sydney and 10,000 in the New South Wales University of Technology).

The Committee's Proposals

The Committee deals calmly and firmly with these alarming expectations. The main need is for money. Following the Committee's recommendations, the Commonwealth Government has offered to contribute over the triennium 1958–60 more than £9 million toward a proposed capital programme of £15 million; emergency grants totalling £4½ million to enable universities to dispose of their most severe embarrassments before 1961; a contribution towards a substantial increase in salaries; and £600,000 towards the extension of residential accommodation in colleges. In addition, the Committee recommends, and the Government accepts, that the Commonwealth contribution for running expenses should be raised by 10 per cent per annum for the triennium 1958–60.

But the Committee has not confined its comments to finance. It suggests that consideration should be given to some sort of close link between the Australian National University, which is a purely postgraduate institution, and Canberra University College, which prepares undergraduates for Melbourne degrees. It is in favour of a second Victorian university in Melbourne and it foresees the need for the expansion of the New South Wales University of Technology to include a second medical school in Sydney, and indeed to become a second full-range university, which might appropriately be called the University of New South Wales.

Of particular interest are the Committee's very frank comments on policy-making in Australian universities. The governing bodies of the State universities are comprised (as they are in the Scottish and modern English universities) predominantly of laymen, with some representation from the teaching staff. The body of professors (commonly called the Professorial Board) is charged, as it is elsewhere, with a good deal of responsibility over academic matters. But by an accident of history, the vice-

chancellor in most universities is not chairman of the body of professors, nor is he their spokesman and protagonist before the governing body. These responsibilities fall to a chairman of the Professorial Board who is elected by the professors. Accordingly, the vice-chancellor finds himself immobilized in the performance of what should be one of his chief functions: to maintain the delicate balance between the lay governing body and the academic staff, and to prevent any suspicion of an employer–employee relationship arising between them. It may well be that the chairman of the Professorial Board performs this function adequately, but (as the Committee says) "this position tends almost automatically . . . to place the vice-chancellor in some other camp" (that is, other than the academic camp). "There comes to arise . . . not a natural unity of governing body and academic, but a natural disunity".

One consequence of this anomalous position of vice-chancellors is that outside their universities, too, they find it difficult to formulate nation-wide policy on academic matters. Consequently, there is a lack of cohesion between universities. This, and the absence of a common initiative, are criticized by the Committee as weaknesses which must be overcome if Australian universities are to discharge their present and future responsibilities.

An Australian University Grants Committee

The Committee's chief long-term recommendation is that an Australian University Grants Committee should be set up, with a full-time chairman, two lay members and five academic members. The Committee emphasizes that the members should not be representatives of Commonwealth, States or universities, but should serve solely in their personal capacities. It should be set up informally, not by statute, and attached to the Prime Minister's Department. Its business should be to advise the Prime Minister on the contributions which the Commonwealth should make to States toward the support of universities, and directly toward the support of the two university institutions under Commonwealth control. The Committee hopes that the States would be willing to seek advice from the proposed University Grants Committee in respect of their local university problems. The proposed Committee would work very much as its prototype does in Britain, by visiting universities and preparing a recommendation for the Commonwealth Government. The Committee believes that financial grants should be made at three-yearly intervals, not five-yearly intervals as in Britain.

Finally, the report reminds its readers that the provision of money and the setting up of a University Grants Committee will not of themselves solve Australia's problems of higher education. The Committee, if it is set up, will have to rely on the Australian universities, through their Vice-Chancellors' Committee, to formulate a national policy for the development of higher education and to take the initiative in putting their views before the proposed University Grants Committee. The Committee would (as in Britain) deal directly with each university over its own programme of development. But it would also have to be in frequent consultation with the Australian Vice-Chancellors' Committee on matters of national policy.

COMMENTARY

To anyone familiar with Australian universities, this report is a masterpiece of discernment, and the Prime Minister's quick response to it is very gratifying. The older Australian universities have a great tradition of scholarship. The intellectual capacities of Australian youth are as high as those of young people anywhere in the Commonwealth. Already in her brief history Australia has made very distinguished contributions to science, scholarship and world affairs. But in recent years her universities have been taxed hopelessly beyond their capacities. The trouble is due partly to the peculiarly Australian conception of democracy which regards the right to attend a university as something in the same category as the right to drive a vehicle on the public highway. But public enthusiasm for enjoying the benefits of higher education has not been matched by public enthusiasm for paying for them. So the universities have had to open their doors to students inadequately prepared to enter and in numbers for which no proper provision had been made; the outcome has been a decade of mass-education, lectures in duplicate, practical classes without enough demonstrators, shortages of equipment, heavy examination failures, and no energy left over for research.

Mr. Menzies's announcement, and his promise that a body having the functions of a University Grants Committee will be set up, disperses most of the clouds in the academic sky. But not all. It still remains to be shown whether a university organized on the Scottish pattern can carry a student population of 14,000–17,000 (as Sydney contemplates) without a breakdown in the machinery of administration. You cannot double the size even of a football team without changing the rules of the game. It is a matter of judgment, of course; but one cannot observe these large Australian universities without wondering whether they should not either re-organize their administration on the American model (with permanent deans and much more decentralization of business into faculty offices), or limit numbers to (say) 8,000 and encourage the foundation of new institutions.

In the long view (not as a way to meet the present emergency) there is something to be said for dispersing the enormous and amorphous elementary classes into colleges somewhat resembling the American junior college. In a country without a strong sixth-form tradition in its schools and with such a widely dispersed population, the educational climate might prove congenial to colleges in the country and in the suburbs of big cities, where young students under personal supervision could cover the intermediate year in basic arts and sciences. Such an arrangement as this would reduce the numbers in the universities; it would provide them with more mature students; and it would enable them to preserve their Scottish pattern of organization.

However, the Committee was wise not to make any revolutionary or unfamiliar proposals in this report. For there is no time to be lost, and the only way Australian universities can prepare for the macro-bulge which is coming is by a vigorous programme of development on conventional lines which the vast majority of academic people will approve. The Murray Committee has made a decisive contribution to Australian higher education; in doing so it has put not only Australians, but also all other academic men in the Commonwealth, in its debt.

SYNTHESIS OF RIBONUCLEIC ACID

By Dr. A. M. MICHELSON

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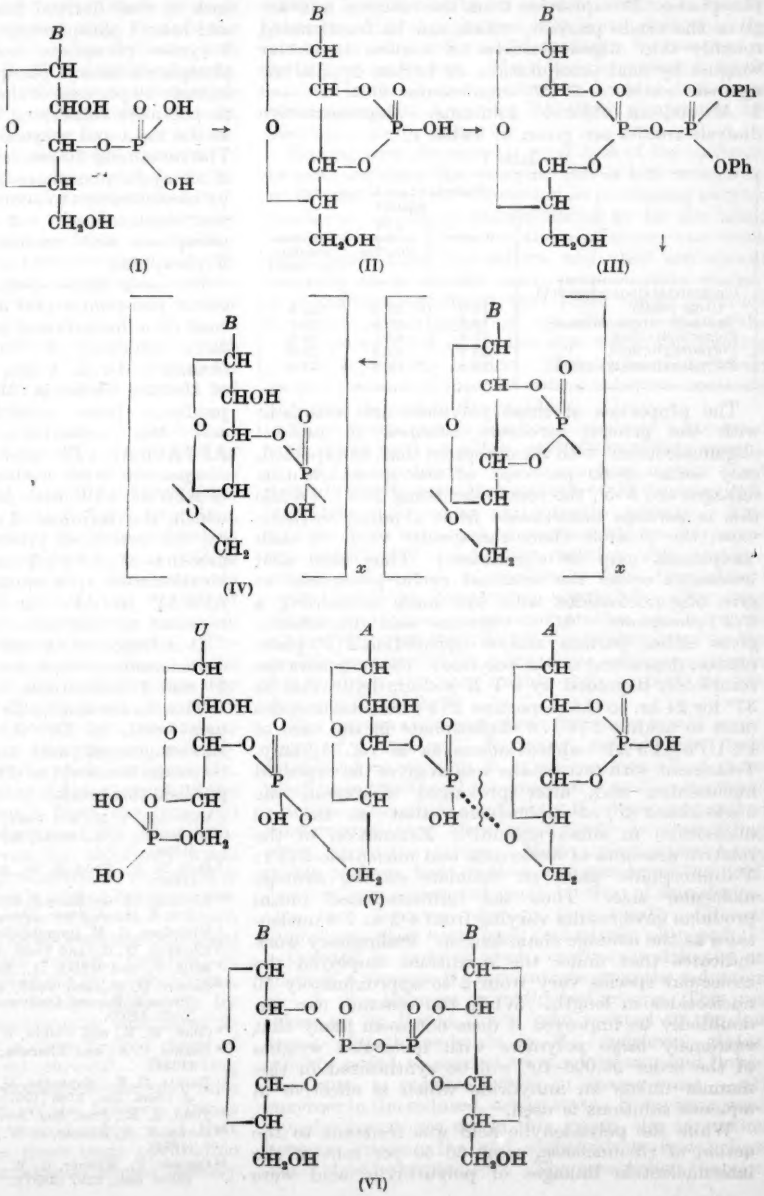
WHILE classical methods have been applied with some success to the synthesis of small polynucleotide derivatives such as dithymidine dinucleotide[1] and adenosine-2′-uridine-5′-phosphate[2] such methods give low yields and require protected nucleoside and nucleotide derivatives. The fully esterified mixed anhydride method has proved successful for di(nucleoside-5′)-phosphates[3], but when applied to the synthesis of a naturally occurring type of internucleotide linkage is unsatisfactory[1]. An extension of this method to the use of nucleoside phosphite anhydrides has been described[3]; but again, yields are low and the method offers little hope for the synthesis of higher oligonucleotides. A preliminary publication by Khorana[4] describes the use of carbodiimide and toluene-*p*-sulphonyl chloride in the synthesis of deoxydinucleotides from thymidine-5′-phosphate.

In view of the difficulties attending the use and removal of protecting groups in the ribonucleotide series, the possibility of polymerization of the readily available 2′(3′)-monoribonucleotides has been examined. It has been found that these nucleotides are easily converted to the nucleoside-2′-3′-cyclic phosphates[5], which are then polymerized quantitatively, by the action of tetraphenylpyrophosphate at room temperature. A number of such polymers have been prepared, including polyadenylic acid, polyuridylic acid and polymers containing adenylic and uridylic acids in various proportions. By using uridine-2′ : 3′-cyclic phosphate-5′-phosphate in the presence of excess adenosine-2′ : 3′-cyclic phosphate, polymers of adenylic acid terminating with uridine-5′-phosphate at the head and adenosine-2′ : 3′-cyclic phosphate at the tail (V) have been synthesized. In addition, by reaction of a mixture of four mononucleotides—adenosine-2′(3′)-phosphate, guanosine-2′(3′)-phosphate, uridine-2′(3′)-phosphate and cytidine-2′(3′)-phosphate—a synthetic 'ribonucleic acid' has been prepared.



In practice, a solution of the mono tri-*n*-octylammonium or mono tri-*n*-decylammonium nucleotide (I) is treated with tetraphenyl pyrophosphate[6] or diphenyl phosphorochloridate[7] and tri-*n*-butylamine to give the cyclic phosphate (II) quantitatively, which is then made to react *in situ* with a further mole of tetraphenylpyrophosphate (added directly or formed in the reaction medium by addition of diphenyl phosphorochloridate). Rapid polymerization, with the evolution of heat, then occurs, presumably through an unstable pyrophosphate (III), which then reacts, either directly or via the dinucleoside pyrophosphate (VI), with the primary hydroxyl groups to give ultimately a mixture of polymers (IV) with 2′(3′) : 5′-phosphate linkages and a tail 2′ : 3′-cyclic phosphate. Precipitation from the reaction mixture gives the crude product, which can be fractionated roughly into oligonucleotides of various molecular weights by acid precipitation, or better, by dialysis against water, 0·5 *M* ammonium chloride and 2 *M* sodium chloride solutions. Representative dialysis results are given in Table 1.

Table 1

	Dialysis of crude polymers against		
	Water	2 *M* sodium chloride	Dialysis residue (per cent)
Commercial ribonucleic acid (from yeast)	14·8	29·8	55·4
'Synthetic ribonucleic acid'	18·5	43·3	38·2
Polyuridylic acid	31·8	45·7	22·5
Polyadenylic acid	24·9	45·5	29·6
Polyadenylicuridylic acid	19·8	46·6	33·6

The properties of these polymers are consonant with the general structure ascribed to natural oligonucleotides[8] with the exception that, as expected, only some 50–60 per cent of the internucleotide linkages are 3′-5′, the remainder being 2′-5′. (While this is perhaps unfortunate from a purely æsthetic view, the possible chemotherapeutic value of such compounds may be significant.) Thus mild acid treatment opens the terminal cyclic phosphate to give oligonucleotides with tail units containing a 2′(3′)-phosphate. More vigorous acid degradation gives either purines and/or pyrimidine-2′(3′)-phosphates, depending on the polymer. The polymers are completely degraded by 0·1 *N* sodium hydroxide at 37° for 24 hr. to the respective 2′(3′)-mononucleotides (and to uridine-2′(3′) : 5′-diphosphate in the case of P5′UP5′AP5′AP—abbreviations as in ref. 1) only. Treatment with rattlesnake venom gives the expected nucleosides, and, after prolonged treatment, the nucleoside-2′(3′) : 5′-diphosphate (that is, the tail nucleotide) in small amount[9]. Estimation of the relative amounts of nucleoside and nucleoside-2′(3′) : 5′-diphosphate gave an estimate of the average molecular size. Thus the unfractionated initial products gave results varying from 4·2 to 7·8 nucleotides as the average chain-length. Preliminary work indicates that under the conditions employed the molecular species vary from 2 to approximately 10 nucleotides in length. While the reaction can undoubtedly be improved it does not seem likely that extremely large polymers with molecular weights of the order 50,000–10[6] will be synthesized in this manner unless an anhydride which is effective in aqueous solutions is used.

While the polyadenylic acid was resistant to the action of ribonuclease, some 50–60 per cent of the internucleotide linkages of polyuridylic acid were cleaved. This figure is aproximate as only a proportion of the material appears as uridine-3′-phosphate, the remainder appearing as di-, tri- and possibly tetra-nucleotides (paper chromatography) containing 2′-5′-internucleotide linkages exclusively. Considerable variation has been observed, and it is likely that under suitable conditions a higher proportion of 3′-5′-linkages would be formed[10,11].

It is clear from the extensive work of Sir Alexander Todd and his collaborators[12] that, under the conditions employed, the nucleoside-2′ : 3′-cyclic phosphates would be polymerized by the action of any acid anhydride where the weaker acid of the anhydride is stronger than the cyclic phosphate. It was therefore of interest to examine the action of an anhydride such as that derived from diphenyl phosphoric acid and benzyl phosphorous acid[13]. When adenosine-2′ : 3′-cyclic phosphate was treated with diphenyl phosphoric–benzyl phosphorous anhydride[13], approximately 50 per cent of the adenylic acid was converted to polymers containing a 5′-benzyl phosphite group at the head and a cyclic 2′ : 3′-phosphate at the tail. The remaining 50 per cent was isolated as adenosine-2′ : 3′-cyclic phosphate-5′-benzyl phosphite, identified by its conversion to adenosine-2′(3′) : 5′-diphosphate[14] via adenosine-2′ : 3′-cyclic phosphate-5′-benzyl phosphate and adenosine-2′ : 3′-cyclic phosphate-5′-phosphate.

By using dilute solutions of the nucleoside-2′ : 3′-cyclic phosphates and allowing the reaction to proceed for a limited time, products containing relatively large amounts of smaller oligonucleotides were obtained. Dr. L. A. Heppel of the National Institutes of Health, Bethesda, Maryland, has examined such products from adenosine-2′ : 3′-cyclic phosphate and has tentatively identified AP5′A2′ : 3′P, AP5′AP5′A2′ : 3′P and AP5′AP5′AP5′A2′ : 3′P by comparison with authentic specimens. Treatment of AP5′A2′ : 3′P with dilute acid gave AP5′AP from which the terminal 2′(3′)-phosphate was removed by the action of prostate monoesterase to give a mixture of A2′P5′A and A3′P5′A. Spleen phosphodiesterase split approximately 50 per cent of the AP5′AP to AP, the remaining A2′P5′AP being resistant to enzymatic cleavage.

It is hoped to extend the work to the synthesis of dinucleoside phosphates and the alkyl esters of the 2′- and 3′-nucleotides.

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BIOCHEMICAL FUNCTIONING OF VITAMIN B_{12}

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THE chemical structure is now known not only of vitamin B_{12} itself but also of many natural and biosynthetic analogues and products of its chemical modification. It is therefore possible to begin to consider such problems as the linkage between the vitamin and peptides or proteins (the intrinsic factor, for example) and the nature of the molecular groupings that may be involved in its biochemical functioning. The 'nucleotide' has two points of attachment to the porphyrin-like 'planar group'. One is through a chain of seven atoms between ring *D* and the phosphorus: the other is by a co-ordinate link between the cobalt and N3 of the benziminazole. It is this second link that is broken in the formation of the purple dicyanocobalamin with alkaline cyanide, leaving the nucleotide part hanging loose, as it were, from its long chain with considerable freedom of movement; this, incidentally, may well be what prevents the dicyano compound from crystallizing. It appears that this link can also be broken by thiocyanate[1], and there is some evidence that linkage with B_{12}-binding proteins also extrudes the nucleotide in this fashion. Thus the two complexes, between vitamin B_{12} and intrinsic factor and the sow's whey factor, respectively, have both been shown to retain the —CN group, and they both fail to react with alkaline cyanide to add a second —CN: this suggests that the position is already occupied, by a group not readily displaced by cyanide[2,3].

Most of the vitamin B_{12} present in animal or bacterial cells appears to be 'bound', presumably to proteins, so that one probably should consider such a complex, rather than the free vitamin, as the biologically functional unit. It is already becoming clear, however, that any one of various slight modifications to the vitamin structure can interfere with its linkage to a highly specific binding factor. This suggests multipoint attachment, such as has been envisaged between enzymes and their substrates[4], involving both the nucleotide and the planar group. The cobalt might well be joined to a nitrogen atom of a histidine residue[5], and one can envisage the nucleotide, on the end of its flexible chain, being free to wrap itself around part of the protein molecule so that, for example, oppositely charged and suitably situated sites on the two molecules are in juxtaposition. It would not then be surprising if the absence of one or both of the methyl groups from the dimethyl benziminazole, or their replacement by other relatively non-polar groups (even by chlorine), made little difference to the biological activity, as indeed it does[6]. This part of the molecule probably represents, as it were, just the end of a line of hooks, by which the vitamin attaches itself to its appropriate biological environment. For the same reason, perhaps, in microbiological systems synthesizing cobalamins, this part of the molecule is freely replaceable by almost any substituted benziminazole one cares to add to the medium or (with a more limited range of organisms) by one of several purines[7]. Reverting to the biological activity of analogues, one may note that even a hydroxyl group on the benzene ring is enough to depress activity considerably, and that exchange of benzene for the more basic pyrimidine ring (to give a purine type analogue) almost entirely destroys activity except for the less specific assay organisms[8]. It is justifiable to conclude that the low activity of the purine analogues is due to their inability to link effectively with specific proteins, because the adenine-containing pseudo-vitamin B_{12} does not interfere (even when it is present in large excess) with the binding of vitamin B_{12} by intrinsic factor or with the uptake of the vitamin from the gut[8,8a].

It seems likely that the highly activated β-position on ring *B* must also be involved in binding to specific proteins. It is this position that is attacked when the vitamin is subjected to mild oxidation by halogens or by oxygen and alkali. The adjacent acetamide chain is then modified and cyclized to yield a lactam or lactone ring fused to ring *B*; these compounds are also biologically inert[9].

Having thus dismissed a good deal of the molecule to accommodate the protein, one is left wondering which parts are left to function in promoting enzyme reactions. A likely answer seems to be the labile amide groups. There are three of these, one much more labile than the others, and they are almost certainly those on the three propionamide chains: it is perhaps significant that these chains protrude from the planar group on the side opposite to the —CN group, that is, on the side where the binding protein is probably located. Thus at least one would be in a position to interact with a substrate molecule anchored in turn to the protein.

These amide groups can be successively hydrolysed with dilute acid or alkali, and the resulting mono-, di- and tri-carboxylic acids are not merely inert towards the B_{12}-requiring mutant of *Escherichia coli*, but they show some anti-vitamin activity. This appears to be enhanced when the acids are converted into substituted amides by reaction with methylamine, aniline, etc. (conveniently with dicyclohexyl carbodiimide as condensing agent)[10,11]. One may deduce that these substituted amides can compete successfully with the vitamin for binding sites on the specific protein (which some other analogues cannot do) but that they are unable then to fulfil its biochemical functions[8a].

The precise nature of these functions is still something of a mystery. So many, indeed, have been attributed to vitamin B_{12} that most or all of them must be indirect, and the problem is to discover what reaction or reactions are directly B_{12}-dependent and so fundamental that they could have an over-riding effect upon the others. Most investigators have, wisely perhaps, kept to their own corners of the field, and few have attempted much by way of integration. One can, however, discern four totally different hypotheses that have been tentatively proposed.

Dubnoff in early *in vitro* experiments detected an effect of a vitamin B_{12} concentrate upon the reduction of —S—S— linkages to sulphydryl groups. This was taken up by Bacon Chow, who pointed to the low serum glutathione-levels in B_{12} deficiency states, quickly raised to normal by the vitamin, and linked this with a possible effect in maintaining —SH enzymes in the reduced, active state. Since important glycolytic enzymes are in this group, the connexion between vitamin B_{12} and carbohydrate metabolism could thus be explained[12]. The established function

of the vitamin in promoting the *de novo* synthesis of the methyl group of methionine from one-carbon precursors in a higher oxidation state must involve at least two steps. Since a folic acid derivative is probably responsible for the actual transfer to homocysteine of a one-carbon unit, it seemed reasonable to postulate that vitamin B_{12} reduces this to $—CH_3$ and perhaps also homocystine to homocysteine[13]. The trivalent cobalt in the vitamin can indeed be reduced reversibly to the divalent state, in which it could serve as a reducing agent, and although the redox potential seems well outside the physiological range, linkage to protein might change it in the required direction. However, there are difficulties; for one thing vitamin B_{12} sheds its cyanide group on reduction and probably also the ability to link with protein. Also, recent experiments appear to disprove any effect on the reduction of homocystine[14].

In lactobacilli, vitamin B_{12} can be replaced by thymidine or other deoxyribosides. The assumption that their synthesis is controlled by the vitamin has recently been confirmed. Further, tracer experiments suggest that the synthesis of deoxyribose is the B_{12}-dependent step. Although these phenomena could not be demonstrated with other species of micro-organisms, it was widely assumed that vitamin B_{12} was concerned in the synthesis of deoxyribonucleic acids, and possibly of ribonucleic acids also, in animals and humans. This was supported by the dramatic increase in red cells and growth of epithelium (relief of sore tongue) on treatment of pernicious anæmia cases. By analogy with the methylation of homocysteine, vitamin B_{12} was supposed to bring about methylation of uracil to thymine (possibly at the nucleoside-level) and so to make available this constituent of deoxyribonucleic acid required for cell division[12]. This hypothesis has also run into difficulties. Doubt has been thrown upon some evidence cited in its support. More directly, recent tracer experiments by Connor Johnson and his colleagues have failed to show any effect of vitamin B_{12} upon the rate of synthesis of either deoxyribonucleic or ribonucleic acid from any of several likely precursors by pigs or chicks[15].

A number of observations have indicated that cyanocobalamin is involved in protein metabolism. Other experiments did not support this as a major role, and until recently there was a tendency to regard any such effects as secondary. Several independent studies have, however, given indications of diminished concentrations of different enzymes (transmethylase, ribonuclease and dehydrogenases[16–18]) in the tissues of B_{12}-deficient animals. Wagle and Connor Johnson have recently reported that the incorporation of carbon-14 labelled serine or glucose into liver protein of pigs or rats is markedly diminished when the animals are deprived of the vitamin[19]. They have also demonstrated large *in vitro* effects in experiments with liver and spleen microsome fractions from normal and deficient animals. The incorporation of labelled amino-acids was about four times as great in the '$+B_{12}$' preparations; moreover, the '$-B_{12}$' ones could be brought up to nearly the normal level by addition of the vitamin[20]. This is the most dramatic effect yet demonstrated in an isolated enzyme system. However, other workers have criticized the experimental conditions and are not yet ready to concede proof of a *direct* effect upon protein synthesis.

A complication in advanced pernicious anæmia is degeneration of the spinal cord, and this condition can be arrested only by vitamin B_{12}, whereas folic acid can bring about hæmatological remission, at least temporarily. Niewig and his colleagues were forced to the conclusion that this implied a control of protein synthesis by vitamin B_{12}, because the protein turnover rate is high in the nerve axons involved in these degenerative changes[21]. Being wedded to the nucleic acid hypothesis, they explained this as an indirect effect, whereby ribonucleic acid functions as a template for protein synthesis, the synthesis of the necessary ribonucleic acid being the B_{12}-dependent step. However, it would be more logical to cite this evidence in support of a direct effect of the vitamin upon protein synthesis. This hypothesis can explain better than most the over-riding effect of cyanocobalamin upon a number of metabolic processes, if it functions by controlling synthesis of the protein moieties of enzymes.

Wokes and Picard[22], noting increased thiocyanate excretion in dietary vitamin B_{12} deficiency, diminished by administration of the vitamin, have put forward a hypothesis based on the supposed lability of the cyanide group and competition of hydroxocobalamin and the enzyme rhodanese for cyanide.

One may now inquire which of these hypotheses accords best with the picture of a vitamin B_{12}-protein complex with its labile amides poised for action. Although no precise mechanism can be envisaged as yet, the likely answer seems to be the protein-synthesis hypothesis, as indeed its latest exponent, Dr. Connor Johnson, has suggested[22]. It is perhaps relevant that an enzyme, recently detected in liver, catalyses the exchange of ammonia from protein amide groups for aliphatic amines, including the ε amine group of lysine[24].

The end of the story is not yet in sight, but there are reasonable hopes that we may soon know more about the mode of action of vitamin B_{12} than we do about some other vitamins discovered much earlier.

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MANAGEMENT AND RESEARCH

THE theme of the annual conference of the British Institute of Management, which was attended by 620 top managers during November 6–8 at Bournemouth, was set in the opening address by the Right Hon. Viscount Monckton of Brenchley. Introducing research as a signpost to better management, Lord Monckton showed that as a nation we are devoting roughly two per cent of our national income to research of all kinds. This appears to be a similar proportion to that for the United States, but our research effort seems to be more dominated by defence requirements, particularly in the fields of aircraft, electronics and atomic energy, than is that of the United States. Partly, if not wholly for this reason, a larger share of the financial burden in Great Britain is carried on the shoulders of the Government. The expenditure of the United Kingdom Government on research and development in the year 1955–56 amounted to more than £200 million, of which only about one-sixth was accounted for by expenditure on civil research. Lord Monckton paid tribute to the important contribution to industrial efficiency which is made by the research activities of business undertakings within their own organizations —activities entailing expenditure many times greater than that of the Government on industrial research— and also raised the basic question of whether, in principle, the consumer of the current products of industry should be called upon to cover the cost of research designed to produce better and cheaper articles for his successors, or whether such ventures should be properly financed by the shareholder by way of lower dividends or by the direct provision of new capital.

Giving pointers for future research, Lord Monckton suggested that "it might be worth while for some internal research to be done on the actual effects upon particular branches of business of changes in rates of purchase tax". Research of this kind might yield results of value in shaping the processes of national economic policy in such a way that full regard is paid to its more remote and long-distance consequences as well as its immediate and direct effects. Another field would be research into "the true causes of breakdowns in employer–workers relations".

The remainder of the Conference was a model of how large national conferences should be organized to give all participants opportunities of obtaining information and discussing matters in which they are particularly concerned or interested. In twenty-five sectional meetings topics ranged from electronic data processing to market research; from operational research to case-studies of successful new companies; from economic research to means of evaluating performance in the sales force; from the use made by industry of research organizations to budgetary control.

One of the liveliest of these sectional meetings was concerned with psychological factors in group relations. The speaker was Dr. A. T. M. Wilson, of the Tavistock Institute of Human Relations, who indicated the main types of investigations which have been made into group relations. By the use of experimental discussion groups, two styles of group leadership were contrasted: the highly directed and the 'actively integrative'. The investigator concluded that the integrative style leads to a more appropriate group atmosphere, to greater group satisfaction with the performance of members, and to greater member satisfaction with group solutions of problems.

Another type of research into group relations has been the descriptive analysis of group relations exemplified by the studies of Woodward and her colleagues with Manchester dock workers, and Scott and his colleagues at the University of Liverpool on the effects of changing methods of steel manufacture on the social structure and group relations in a mill. Similar work has been done by Trent and Bamforth, who, in a study of the longwall system of mining, have presented one of the most detailed analyses yet available of group relations in a production system; Burns has recently examined cliques and cabals in industrial firms, while Mackenzie has discussed the relationship between production and inspection groups.

Studies of the kinds described are adding to our knowledge of group relations in actual working situations beyond the superficial level at which they have often been described and considered in the past. More important, they illustrate how knowledge can be deepened by the use of a systematic framework derived from the social sciences. The full value of such studies will not be easy to assess until it is possible to see their results in the new generations of managers whose training has in part been based on discussion of such research and its implications.

A different kind of study has been made with the experimental reorganization of working groups in actual industrial situations. One of the best-known is that of Rice, who, in an Indian textile factory, had an opportunity to initiate an experiment in complete reorganization of a working team, first in an automatic and later in an ordinary weaving shed. With the agreement of management and trade unions, and with the collaboration of the workers concerned, he was able to reconsider the whole basis of dividing up the activities needed to service the working looms. In the automatic weaving shed he reduced the twelve categories of job to three and completely altered the supervisory pattern. The results were to increase efficiency by about fifteen per cent. A completely reorganized managerial system emerged.

One extremely important finding of this work can be expressed as follows: the technological character of a particular production system does not completely determine the structure of the working team by which any such system is operated. The studies which Rice has published demonstrate the possibility that there may be much to be gained from a consideration, first, of the objectives of a particular production team and, secondly, various possible forms of team structure.

Studies of communication in small working groups have also been made and clearly showed that communications are particularly vulnerable to the creation of informal procedures, and the creation of 'by-pass channels', and that the existence of informal procedures can serve as a signal to the investigator to look for discontent originating in circumstances perhaps quite unrelated to communications themselves.

There have been many experimental training conferences in group relations, and these have varied patterns of component activities. Wilson also described the use of groups; theory sessions: role-playing; and short projects to illustrate the project method of teaching.

In the ensuing discussion it was made clear by management representatives that useful research findings in group relations would continue to be unused until their interpreters were able to free themselves from unnatural jargon and obscurantism.

Confusions about productivity and profits were analysed by R. J. Brech (Unilever Ltd.), who showed that productivity is of little value in assessing the current operations of a firm.

Productivity is simply an arithmetic ratio expressing a technical concept. It describes the relative change in output from a given change in input. If output goes up or down more than proportionately with the increase or decline in input, then productivity increases or declines. As a technical concept it has its value, since once it is known, changes in output can be predicted for given changes in input. But from a management point of view, such a concept has little significance. A manager, if he is to run his business intelligently, has to use economic concepts rather than technical ones. The difference between an economic and technical concept is still not fully appreciated by the business community. The essence of business is the ability and willingness to take a risk, and profits are the legitimate return for risk-taking. Profits are based on relative prices and costs —on economic considerations and not technical ones.

How far does the concept of productivity help the manager to maximize his profits? Productivity ratios can be (and perhaps should be) worked out for all significant factors of production used in any particular process—labour, materials, machinery, floor space and so on. But the ratios themselves are of little value, since they cannot be compared against a standard. A more significant feature is the change and the rate of change in the ratios over time. But when all these ratios and changes in ratios have been worked out, how do they help the manager to maximize his profits? If the manager can legitimately assume that relative prices are unchanged, then an increase in productivity of any factor of production will mean a decline in cost per unit of output. Productivity as a concept is only helpful as a step in calculating changes in costs; and even then it can be misleading since it turns attention away from the real problem confronting management—namely, the provision and use of proper information.

The basic information necessary for taking management decisions is the normal accounting and statistical data, and these should be designed in such a way that they can be used for most, if not all, management decisions. Unfortunately, most accounting data are usually presented in such a form and so late as to be of little value to the manager in taking current decisions or in looking to the future. Accountants have had to concentrate much more on form and presentation of data rather than on the content and on the concepts on which the data are based. A manager, however, is an 'operational economist': all his decisions are basically those connected with economic problems in the sense that they are concerned with relative prices. Any accounting information intended to help management to take the right decisions must be based on economic principles.

A sectional meeting which attracted considerable interest was one concerned with a woman's approach to management. The speaker was Elizabeth Barling (John Lewis Partnership), who suggested that in some civilizations men enjoy much more freedom than women. In Western countries, however, men enjoy considerably less freedom and are inured to considerably more discipline.

Most men have wives and families to support and think about. Most career women either have husbands who have jobs or are unmarried and, economically, have only themselves to think about. Men have to play safer, so far as their jobs are concerned, than women. Women will not stay in jobs they do not enjoy. Men mostly will—if security and perhaps pensions depend on their doing so. Creativity is essentially a product of freedom. Staying in a job that is disliked or playing safe in a job that is disliked are not the conditions in which creativity flourishes. If women are less inured to discipline—and if industry wants their ideas—then industry must recognize that their creativity may depend on conditions of freedom and do what it can to foster those conditions.

It is incompetence in dealings with people that holds British industry back. How to get people to work effectively together? Where to find an incentive that really lasts? How to remove the traditional suspicions and fears that prevent workers from going all out to increase national productivity and their own standard of living? How to turn not just virtues but the weaknesses in human nature to good account in the interest of the firm and of the country? These are the real problems of to-day and women have a part to play in their solution.

The implications of budgetary control for financial research were considered by A. E. Tunley (Harris Lebus Ltd.). The kind of research into the completed budget would raise such questions as:

(1) Is the estimated profit up or down compared with previous years, and is this in keeping with the trend in industry generally and in the particular industry in which the organization operates? Does the profit appear in general to reflect a comparable achievement to that of its chief competitors?

(2) Does the estimated profit in relation to the estimated capital employed show an improvement or a deterioration over previous periods, and do these variations reflect a general trend in the industry or are they peculiar to the organization? If not, are they temporary and a part of a deliberate policy of long-term improvement?

(3) Of equal importance in testing the efficiency of an organization is to see that the rate of profit earned on profits retained in the business is at least equal to the profitability of the original capital—the true test of the growth of a company.

A change in the profitability of capital employed can arise from several causes, and it is desirable to investigate which of these operated. It may be that costs as budgeted have increased, and it is not thought possible to pass this on to customers. It is important to consider why costs have increased and whether the increase is avoidable. Various ratios and indices of measurement will lead to further investigations, such as:

(i) the elements of manufacturing, distribution and selling costs expressed in terms of a suitable unit which eliminates the price element (that is, a productivity unit or a selling unit) to indicate trends by comparisons with previous years.

(ii) comparisons of labour efficiency as projected in the budget compared with past records.

A fall in profitability of capital employed could be due to a slowing down in turnover in capital. A breakdown of the elements of capital employed in relation to volumes of sales should give a lead as to where the slow-down is occurring. The fall in profit in total and in relation to capital employed may be due to a fall in turnover. If, however, the problem has remained intractable, and the shrinkage in turnover seems to be progressive over a long term, it must mean that there is either a developing shrinkage in the market for the company's products or that the company itself is becoming progressively uncompetitive.

If the problem is the former one, then the company must consider some more profitable use of capital.

If the problem seems to be one of competition, the company must discover whether the reason is price—which may be due to: inefficiency in direct cost; too high an overhead burden; an attempt to obtain too high a margin.

All these tests—and others—applied to the trend of an organization's figures in the final budget will indicate how a business is progressing in relation to its own standards. The question still remains whether it is improving its position in relation to its competitors and in relation to industry generally; whether it is better or less than average; whether it is showing sound incipient strengths that could well be exploited. It is difficult to establish these facts unless there is some established method of comparison between firms. These take the form of detailed exchange of cost information on a common costing method or financial ratios.

The part the universities could play in management research was discussed by Prof. N. C. Hunt (University of Edinburgh), who suggested that many apparent personality problems in industry are, in fact, organizational problems. Given that 'organization, people would react similarly however well trained and well chosen they might be. They create situations in which workers who have been educated to be active, independent adults with real abilities are required to behave more and more like infants—dependent, subordinate and passive—even though they may be well paid for it and well treated. This must tend to frustrations which in turn lead to an increase of aggression and a reduction of efficiency. In this situation managers are asked to do the impossible. Whether they are autocratic or democratic, optimum results are persistently elusive.

Much could be gained by researchers going into businesses without a detailed frame of reference to investigate a particular problem. Free to follow their own devices they might well stumble upon important discoveries which might have been missed had a definite course been set. University researchers must keep themselves free to tackle problems in their own way, however 'practical' these problems may be. The business world would do well to make it possible for them to investigate problems which are not obviously practical and which may seem irrelevant.

Research in management must be a co-operative venture between the universities and the business community. It cannot be undertaken on any scale by business men immersed in the day-to-day problems of management. Neither can it be done by academics confined to laboratories and libraries.

Besides the sectional meetings, twenty-six discussion groups were arranged concerned with subjects varying from management ratios in the small firm to research in labour turnover; from research into industrial markets to ways in which management can be kept informed of scientific development and research findings. The groups led to extensive shaping of experience which should prove to be of considerable value to British industry.

The Conference was also addressed by Dr. A. King, deputy director of the European Productivity Agency, who illustrated the value of research as an investment.

T. H. Hawkins

OBITUARIES

Sir Ernest Kennaway, F.R.S.

Through the death of Sir Ernest Kennaway, which took place on January 1 (peacefully in his sleep, at St. Bartholomew's Hospital), cancer research in Britain has lost its *doyen*, and experimental pathology one of its greatest figures.

Ernest Laurence Kennaway was born on May 23, 1881, the son of Laurence James Kennaway, of Exeter. As a scholar of New College, Oxford, he took a first-class in the final honours school of natural science in 1903. Proceeding to the Middlesex Hospital with a university scholarship, he graduated B.M., B.Ch., in 1907, and D.M. in 1911. After working for short periods at the Lister Institute and at University College, London, he then successively became demonstrator of physiology at St. Thomas's Hospital (1908), Hulme research student at Brasenose College, Oxford (1909), and demonstrator of physiology at Guy's Hospital (1909–14). In 1911, he was awarded a Radcliffe travelling fellowship by the University of Oxford, and studied at Heidelberg and at Munich. In 1915, he obtained the D.Sc. of the University of London.

He joined the staff of the Cancer Hospital in London as physiological chemist in 1921, and in due course became director of its Research Institute (now the Chester Beatty Research Institute), in succession to Dr. Archibald Leitch; and was also elected professor of experimental pathology in the University of London. He retired from the staff of the Royal Cancer Hospital in 1946, becoming professor emeritus, and continued his researches at St. Bartholomew's Hospital. In a long life he accumulated many honours—the William Julius Mickle fellowship of the University of London, the first award of the Anna Fuller Memorial Prize (jointly), the Garton Prize of the British Empire Cancer Campaign, the Walker Prize of the Royal College of Surgeons of England, the Baly Medal of the Royal College of Physicians of London, the Osler Memorial Medal of the University of Oxford, and an honorary fellowship of New College—among others. He was elected Fellow of the Royal Society in 1934 (and a Royal Medallist in 1941),

and of the Royal College of Physicians in 1937, and received the honour of knighthood in 1947.

In the period from about 1910 to 1920, Kennaway was the author of a whole series of papers, on a great diversity of topics, which unmistakably revealed the breadth of his knowledge and interests in chemistry, physiology and pathology, and gave a taste of things to come. Certainly, however, it is upon his massive achievements in the sphere of malignant disease that his name and fame are based and will endure. In the early 'twenties, great efforts were under way to elucidate the nature of the cancer-producing agent in tar and pitch, following the successful induction of cancer through application of coal-tar to the rabbit skin by Yamagiwa and Ichikawa (1915), and in the mouse by Tsutsui (1918). Between 1921 and 1926, Bloch in Zurich had found that the active substance was concentrated in the higher boiling fractions as a neutral compound probably belonging to the class of cyclic hydrocarbons. In 1924–25, Kennaway succeeded in producing carcinogenic tars by the pyrolysis of many organic materials, and by leading acetylene and isoprene with hydrogen through heated tubes. The tars obtained at successively higher temperatures showed an ascending potency, and the results could be explained by assuming that acetylene was a common decomposition product, and that the carcinogenic material was built up from it. In all this work, Kennaway ever acknowledged the value of Berthelot's classical paper of 1866, describing for the first time the production from acetylene of these very kinds of molecule.

We are fortunate, indeed, that he left his own characteristic account of these and later developments (*Brit. Med. J.*, **2**, 749; 1955), setting forth their history, and making clear the essential part played by others at the Cancer Hospital—W. V. Mayneord's examination of the fluorescence spectra of the carcinogenic tars, and the discovery of their special qualities (1927); the development of this clue by I. Hieger; the discovery that 1 : 2-benzanthracene gave a spectrum similar to that of the carcinogenic mixtures; and J. W. Cook's studies of the benzanthracene homologues. About this time, Clar had just published methods for the synthesis of certain benzanthracene hydrocarbons. These compounds were tested by Kennaway and Hieger (1929–30), who soon observed positive results with 1 : 2 : 5 : 6-dibenzanthracene: this was the first pure compound manifesting pronounced carcinogenic properties, and one cannot forget the satisfaction and modest pride which Kennaway obtained from the fact. The fluorescence spectrum—in Kennaway's words "the single thread that led all through this labyrinth"—was also used in the concentration of the agent from coal-tar pitch, culminating in the isolation of a hydrocarbon which showed the characteristic spectrum and which proved to be highly carcinogenic. Its properties suggested one of the two benzpyrenes, and these were synthesized by J. W. Cook and C. L. Hewett, who were then able to prove the identity of one of the compounds (3 : 4-benzpyrene), and the substance from pitch. All these, and many other results which Kennaway alone inspired, are embodied in numerous papers (many of them classics) in the scientific literature at home and abroad, and, most notably, in a celebrated series which appeared in the *Proceedings of the Royal Society* during 1932–42. What undoubtedly emerged from almost thirty years of brilliant work was a satisfying and indeed beautiful correlation between chemical constitution and biological action, whereby the carcinogenic sub-classes of polynuclear hydrocarbons could clearly be related to the parent substance phenanthrene, in a system suggesting dependence upon certain optimal features of molecular size, shape, substitution and reactivity. But we must not minimize another result—namely, the profound practical influence which was exerted upon the whole of cancer research, and indeed biology at large, from the mere availability of these potent carcinogens, so rendering possible, and catalysing, numerous other investigations, and additions to knowledge, which could not have been attained without them.

No imagination is needed to see how this career demanded a patient sense of purpose over so many years. In certain ways Kennaway possessed a unique combination of qualities—in his intellectual aptitudes, his chemical sympathy and knowledge, and in his unrivalled skill in applying them to physiology and pathology. Apart from his modern scientific bent, he was also a true naturalist, believing greatly in field work and epidemiology. His standards of scientific evidence were rigorous and severe, to the point of austerity. His experimental methods were simple, practical and decisive, and a delight to watch in execution. He was much less interested in hypotheses and explanations, and although his own work had lain almost entirely in the chemistry of carcinogenesis, he remained completely open and free to accept any other mechanism or interpretation—provided only that the facts were ascertained, and not an instant before. Added to all these gifts, he was a master of scientific expression, and of English construction.

We have lost a great discoverer and scientific worthy. Among his personal attributes two things prevailed. First, his profound agnosticism. Secondly, a superb fortitude, which enabled him to triumph over disability, illness and accident, and to continue his researches long after his official retirement and almost to the day of his death. Of course, he had many other interests, and many human concerns which he did not parade and which, contrariwise, he often tried to conceal. It is idle to pretend that Kennaway was easy, or that he could readily apply to ordinary judgments the quality of detachment he brought to his special field. But for how many can anything of the kind be claimed? Although he could be subjective and quixotic even more than most of us, these foibles were mere additions—often endearing—to the fascination of an already complex human character, and had no real bearing on the solid worth of his permanent achievement.

No appreciation could be complete which failed to refer to a factor at all times apparent to those who worked with him—the part played by Lady Kennaway in every aspect of his life and contribution. Not in any small measure due to his helpmeet, he wrote a vast chapter in cancer research and chemical pathology, which nothing can diminish, or take away.

A. Haddow

Dr. A. J. Ewins, F.R.S.

Dr. Arthur James Ewins died after a long illness on December 24, aged seventy-five. He will long be remembered for his discovery of several important chemotherapeutic remedies.

Ewins was born in 1882 at Norwood, the son of Joseph Ewins, who was a signalman on the London and South-Eastern Railway. A scholarship took him to Alleyn's School, Dulwich. Leaving at the age of

seventeen, he obtained a position as technician at the Wellcome Laboratories, Herne Hill, working under Dr. (later Prof.) G. Barger. By evening studies at Chelsea Polytechnic, he graduated with honours in 1906, and was promoted to the staff of the Wellcome Laboratories. Soon he began to co-operate with Dr. (later Sir) Henry Dale in work on acetylcholine, other choline esters, and the ergot alkaloids, and this formed the basis of a long and valued friendship between them. When Dale entered the service of the Medical Research Committee (later Council) in 1914, Ewins did the same, and worked with him in the production of 'Salvarsan' and other drugs formerly made in Germany and by then no longer available. Early in 1917 he was offered an attractive appointment with May and Baker, Ltd., which he accepted; and he continued with this firm for the rest of his scientific life, becoming the head of its chemical research department and director of research.

Ewins's main interest was in chemotherapy. After much work on the organic arsenicals, he turned his attention to other fields. In the middle 1930's Dr. E. M. Lourie and Prof. Warrington Yorke, of Liverpool, had discovered that synthalin was very active in killing trypanosomes *in vitro*. Following development work by the late Dr. Harold King at the National Institute for Medical Research, Ewins took up this lead and synthesized a long series of diamidine compounds, of which the most active, pentamidine, has proved of great value in combating sleeping sickness in Africa. One intramuscular injection is enough to protect a man against this infection for six months, and this procedure has been applied to millions of people in tropical Africa to safeguard them against this dangerous disease. Another member of the same series—phenamidine—is widely used for curing babesiasis (redwater) of cattle and dogs. These drugs are also active against kala-azar.

The work for which Ewins is best known was his discovery of the famous '*M* & *B* 693', or sulphapyridine as it was later named. After prontosil had been prepared by Domagk and Mietsch in 1933 as a cure for streptococcal infections, the French workers, Trefouel and Bovet, showed that the antibacterial activity resided in the simple structure—*p*-aminobenzene sulphonamide, or sulphanilamide. The early attempts to obtain greater and wider activity by modification of this structure were not very successful until in 1937 Ewins and Phillips inserted a pyridine group in the sulphonamide radical. This compound was tested by Sir Lionel Whitby and found to be very active in curing mice experimentally infected with pneumococci. The new compound was quickly applied to human infections and proved to be brilliantly successful, and for the first time in medical history lobar pneumonia could be cured by a simple drug. Later, sulphapyridine was supplanted by other more active and less toxic compounds (including sulphathiazole synthesized by Ewins and Newbery), but the inspiration of its discovery will long be remembered. In 1943, Ewins was elected to the Royal Society. He continued to direct the research organization which he had built up until his retirement in March 1952.

Ewins was a simple and modest man, but he knew his own mind, and once he had made a decision he persevered with determination. He was well liked and well respected. Besides his scientific work, his chief pleasures were working in his garden, reading and motoring. He leaves a son and a daughter.

F. Hawking

NEWS and VIEWS

The United Kingdom Atomic Energy Authority

Mr. W. R. J. Cook, deputy director of the Atomic Weapons Research Establishment, Aldermaston, has been made a full-time member of the Atomic Energy Authority. This new appointment makes it possible to progress towards certain alterations in the structure of the Authority. Three full-time members of the Authority have hitherto each had three types of responsibility. First, they have had executive control of one or more of the Authority's establishments. Second, they have been responsible for formulating policy on, and for broad oversight of, the subjects constituting their own special fields (research, production and engineering, and weapons). Third, they have had to join with their colleagues in considering and deciding jointly on the general policies to be pursued by the Authority. The purpose of the alterations which are being made is to free these members from their executive duties, and thus enable them to devote more time to their other responsibilities. Sir John Cockcroft, who has since the setting up of the Authority held the posts of member for scientific research and director of the Atomic Energy Research Establishment, Harwell, will be succeeded in the latter post by Dr. B. F. J. Schonland (the present deputy director).

Mr. Cook will be responsible at Board-level for policy questions concerning the Authority's production factories and the engineering aspects of the Authority's work. Since Sir Leonard Owen was appointed managing director of the Industrial Group in September 1957, he has had executive charge of the establishments in that Group. Sir William Penney will continue to be member for weapons research and development and, pending the appointment of a new director of the Atomic Weapons Research Establishment, he will continue to hold that post also. The duties of Sir Donald Perrott, member for finance and administration, and of Mr. W. Strath, member for external relations and commercial policy, are unchanged. Mr. Cook and Dr. Schonland will take up their new appointments on February 17.

National Research Council of Canada: Dr. J. B. Collip, C.B.E., F.R.S.

The retirement is announced of Dr. J. B. Collip from the directorship of the Division of Medical Research of the National Research Council of Canada. He has held this appointment since 1947 when the new Division of Medical Research superseded the old Advisory Committee on Medical Research, of which Dr. Collip had also been chairman since 1941. Dr. Collip, of course, is best known for his work in purifying the early preparations of insulin and thus playing a leading part in making this hormone available for general clinical use. Dr.

Collip, however, has many other claims to the respect and admiration of the scientific world. His work with extracts of pancreas seemed to whet his appetite for hormones, and he next attacked the parathyroid gland which at that time was something of a mystery as an endocrine organ, and he succeeded where others had failed in obtaining a reproducibly active preparation. Next he worked on the newly recognized hormones of the anterior pituitary lobe, gonadotrophin, thyrotrophin and adrenocorticotrophic hormone, with a brief but productive excursion to the placenta. From the latter organ he prepared both œstrogenic and gonadotrophic extracts upon which he worked for some time in 1930 at the National Institute for Medical Research in London. Since the beginning of the Second World War his time has been taken up very largely by organizational work, partly in connexion with his appointment to the National Research Council but also as dean of medicine at the University of Western Ontario, a position which he still holds. No one meeting Dr. Collip could fail to be aware of his active and forceful mind or of the keen intelligence with which he dissects the various parts of a problem, and it is fitting at this moment to pay tribute to his services to medical science generally and to the National Research Council of Canada in particular.

Prof. R. F. Farquharson, M.B.E.

The recent appointment of Prof. Ray Fletcher Farquharson as vice-president (medical) of the National Research Council of Canada, in succession to Dr. J. B. Collip, is one which is regarded with much pleasure and satisfaction by physicians and scientists alike throughout Canada. Born in Claude, Ontario, Dr. Farquharson graduated from the University of Toronto Medical School in 1922, and after six additional years of postgraduate training in internal medicine in Toronto and in Boston he was appointed to the staff of the University of Toronto as demonstrator in medicine and began to practise as a medical consultant. In both his university and professional work he was eminently successful and he rose rapidly in academic rank. In 1935 he was appointed assistant professor of medicine in charge of therapeutics and in 1947 he succeeded Prof. Duncan Graham as the Sir John and Lady Eaton professor of medicine and head of the Department of Medicine in the University of Toronto and as physician-in-chief to the Toronto General Hospital—posts which he still holds. During the Second World War he was on active service with the Canadian Armed Forces, serving with the rank of wing-commander as consultant in medicine to the Royal Canadian Air Force, and from 1948 until 1951 he was a member of the Defence Research Board of Canada. He is a Charter Fellow of the Royal College of Physicians and Surgeons of Canada and, in addition to serving on its Council for many years, was president of the College during 1945–47. He has been associated with the National Research Council of Canada since 1945, first as a member of the Division of Medical Research and then as a full member of Council. With his recent appointment as vice-president (medical) he will be in charge of all the medical activities of the Council. In spite of his many other activities, he has found time to carry out and publish an impressive amount of clinical research; his work on calcium metabolism, pernicious anæmia, Simmonds' disease and anorexia nervosa is particularly well known. Widely recognized throughout Great Britain and the United States as well as in his own country as an outstanding physician, a first-rate investigator, an enthusiastic teacher and an able administrator, and held in the highest esteem and affection by his colleagues and patients, he brings to his new post a fund of ability and experience which augurs well for medical research in Canada.

Applied Mathematics in Durham: Prof. K. Stewartson

Dr. Keith Stewartson, reader in applied mathematics in the University of Bristol, has been elected to the newly created chair of applied mathematics in the University of Durham. Dr. Stewartson was a Wrangler in Part 2 of the Mathematical Tripos in Cambridge in 1944 and then had his studies interrupted by two years national service in the Ministry of Supply. He returned to Cambridge in 1946 to read for Part 3 of the Mathematical Tripos, in which he gained a mark of distinction in the following year and the Mayhew Prize. He then took up research in fluid mechanics and was awarded the Rayleigh Prize in 1949 for an essay on supersonic flow. He took his Ph.D. in 1949 and was at the same time appointed lecturer in the University of Bristol. He became reader in 1954 on his return from a year's leave of absence spent as a research fellow at the California Institute of Technology.

Dr. Stewartson's contributions to fluid mechanics have come under the headings of supersonic flow, magneto-hydrodynamics, boundary layer theory and rotating fluids, and of these perhaps the last two are the more important. In earlier work on boundary layers he showed (as did Illingworth simultaneously) that under certain special, but not unrepresentative, conditions it is possible to correlate the flow in compressible boundary layers, and he has also concerned himself with the phenomenon of separation, both shock-induced and in incompressible flow. His work on the mechanics of rotating fluids has comprised contributions to inviscid theory in such problems as the motion of a sphere along the axis of a rotating fluid, and to viscous theory in such problems as the flow between two rotating coaxial disks and the discussion of almost solid rotations.

University of Durham Computing Laboratory

The Computing Laboratory of the University of Durham was officially opened on January 21 by Sir George Thomson, who spoke of the wide field of application of electronic computers, not only as an aid in scientific calculation, but also in the study of the humanities by the analysis of literary style. The Laboratory has recently installed the Ferranti 'Pegasus' computer 'Ferdinand' (FERranti DIgital Numerical Analyser Newcastle and Durham). The cost of the machine has been met by a grant from the University Grants Committee and by contributions from firms in the north-east of England. 'Ferdinand' was demonstrated to representatives of many firms after the official opening and naming ceremonies. The machine will be used for research work by university departments and will also be available for hire by industrial and commercial concerns.

Royal Photographic Society Award

The Royal Photographic Society of Great Britain has awarded its Silver Progress Medal for 1957, the Society's highest award, to Dr. Edwin H. Land, president of the Polaroid Corporation, Cambridge,

Massachusetts, for his outstanding contributions towards the development of synthetic polarizers for light (for example, 'Polaroid'); of stereoscopic photography using polarized light one-step photography ('Land' camera); of the ultra-violet colour-translation microscope; and of the use of plastics and colloids in optics. Honorary Fellowship of the Royal Photographic Society has been conferred upon Dr. John I. Crabtree (Research Laboratories, Eastman Kodak Co.), who has been responsible for major developments in the practice of processing black-and-white still- and motion-pictures; and also upon Dr. E. H. Land.

Pooling Scientific Resources in the Western World

In a written answer given on January 21 in the House of Commons to a question regarding the Government's policy as to the pooling of scientific knowledge in the interests of international peace and co-operation, Mr. R. A. Butler re-affirmed that the Government is in favour of pooling scientific resources. He added that discussions with other members of the North Atlantic Treaty Organization and the Organization for European Economic Co-operation are proceeding with the view of promoting this continuing co-operation. The most important recent step towards scientific co-operation in the government field has been the joint decision of the North Atlantic Treaty Organization to establish a Science Committee and to appoint a Science Adviser to the Secretary-General.

Technical and Technological Education in Scotland

Replying on January 21 to a question in the House of Commons regarding the expansion of scientific and technological education in Scotland, the Joint Under-Secretary of State for Scotland, Mr. N. Macpherson, said that projects to the value of £7,300,000 have already been approved by the Secretary of State. He added that further projects to the value of £1,200,000 are being considered and it is expected to receive shortly a scheme for the remaining £1,500,000. Every opportunity is being taken by means of conferences and other forms of publicity to encourage employers and young workers to make full use of the facilities available.

National Science Foundation Grants for Research Reactors

Two major grants for research reactors are to be made by the National Science Foundation, namely, a 300,000 dollar grant to the State College of Washington, at Pullman; and a 150,000 dollar grant to the University of Virginia, at Charlottesville. The reactor facility to be constructed at the State College of Washington will be a swimming-pool type, heterogeneous reactor using enriched fuel elements and moderated by water. The reactor will have twelve beam ports, a thermal column, and at a power level of 100 kW. will provide a core flux of about 10^{12} neutrons/cm.^{2}/sec. The project is under the direction of Harold W. Dodgen, of the Department of Chemistry. The proposed facility is near seven other institutions of higher learning and is expected to contribute to the development of a regional programme in reactor research and training in nuclear technology. The project is also being assisted by the U.S. Atomic Energy Commission. The research reactor at the University of Virginia will also be of a swimming-pool type. The School of Engineering is participating in the design and construction of the reactor, thereby making possible appreciable savings in cost. The project is under the direction of Lawrence R. Quarles, dean of the School of Engineering. The staff has been actively planning research with nuclear radiation in the fields of biology, chemistry, engineering, medicine and physics. Nuclear fuel for both reactors will be provided by the United States Atomic Energy Commission.

The Midwestern Universities Research Association

The National Science Foundation has awarded a grant of 160,000 dollars to the Midwestern Universities Research Association, Madison, Wisconsin, for the support of basic research entitled "High Energy Accelerator Studies". The research is under the direction of Keith R. Symon, of the University of Wisconsin. Since 1953, scientists of the Association have been investigating methods of accelerating particles to energies of billions of electron volts. They discovered that a machine based on the principle of a fixed-field-alternating gradient was feasible, and a model was built to demonstrate this principle. The basic theory of accelerators was also developed to a point in advance of anything that had thus far been achieved. The work was facilitated by the use of high-speed computing machines, which were used to carry out analyses not otherwise possible. With the new grant, which supplements funds received from the U.S. Atomic Energy Commission, the Midwestern Universities Research Association expects to continue those studies of new ways of producing high-energy collisions involving beams of protons. It will continue to investigate the orbits and accelerating field configurations for the intersecting-beam method of producing 'effective' energies of tens of billions of electron volts. Theoretical studies will be made of the temporary 'stacking' of orbiting particles. Because the feasibility of an intersecting-beam accelerator depends on the intensity in the beam, it is planned to build a new pilot model to test the theoretical calculations that have been made on beam intensity. The model will operate at 50 million eV. and be so built that counter-circulating beams of particles can be studied. The radiation effects and the spurious interaction of these circulating beams will also be investigated.

History of Libraries

In his inaugural lecture, "The Golden Chain: a Study in the History of Libraries", at University College, London, on November 21, Prof. R. Irwin suggested that the history of libraries is essentially concerned with the conquest of space and time by the art of recording communications, and involves not only the history of scholarship in its narrower sense, but also of human civilization, culture and literacy. Moreover, he pointed out that the genealogy of scholarship and letters is as complex as any family tree. Books have their ancestry and descendants, and a book is a kind of reincarnation of the author that gradually gathers to itself an independent life of its own. An author's literary offspring are always the result of a marriage between his own mind and the communicated experience of other minds, in the main received through the medium of books, so that the conception and birth of the new book commonly occurs in the author's library or, for a scientist, in his laboratory. Prof. Irwin suggested that a library can be defined as a community in which reader and writer meet, to which both contribute something of

value, mutually forging the links of the chain as it passes from mind to mind and from generation to generation. At the centre of this community is the librarian, with his two main duties of preserving for future readers the books in his care and of caring for the needs of every member of that community and for the chain of recorded tradition which is continually being corrected, strengthened, extended and passed onwards.

Indian Ephemeris and Nautical Almanack (1958)

The publication of the first issue of the Indian Ephemeris and Nautical Almanack (pp. xviii+392. Delhi: Manager of Publications, 1957. Rs. 12) marks an important step in the plans for the development of astronomical studies in India. The preparation of such a work was first recommended by the Planning Committee for the development of astronomy and astrophysics set up in 1945 under the chairmanship of the late Prof. M. Saha. In 1952, the Government of India appointed a Calendar Reform Committee with the object of unifying the diverse indigenous calendars (see *Nature*, 178, 402; 1956). This Committee recommended that an Indian Ephemeris and Nautical Almanac for each year should be compiled and issued by the Government. The work was started by the Council of Scientific and Industrial Research under the Ministry of Natural Resources and Scientific Research, but it has now been taken over by the Indian Meteorological Department under the Ministry of Communications, and a Nautical Almanack Section has been set up at the Regional Meteorological Section, Alipore, Calcutta. At the end there is a section on Indian astronomy, added in accordance with the recommendation of the Calendar Reform Committee. The work of compiling and publishing the present issue has been under the supervision of Sri N. C. Lahiri, who has also been responsible for the introduction, dealing with the history and development of astronomy in India from about 1350 B.C.

Vacuum Drying Oven

The Gardiner precision vacuum oven, developed by S. D. Gardiner in the laboratories of Tate and Lyle for the determination of the loss in weight on heating sugar syrups and molasses, is now in production by Griffin and George, Ltd., Ealing Road, Alperton, Wembley, Middlesex, from whom particulars of it may be obtained. In this oven the sample is taken into solution and distributed over aluminium powder. It is then heated in a vacuum while a current of dry air or inert gas is taken over its surface. Suitable arrangements for heating the specimen are incorporated. The oven will be suitable for use with various types of materials, including those of a labile nature.

Developmental Potentialities of Fern Leaf Primordia

E. G. Cutter (*Annals of Botany*, N.S., 21, 343; 1957) has noted that when young visible primordia, which are not yet determined as leaves, on inactive apices of *Dryopteris aristata* are isolated by four shallow incisions, they undergo regression and disappear; but if the adaxial incision is afterwards deepened, some of the primordia are stimulated into a renewal of growth. About three-quarters of this number developed as buds, the rest as leaves, some of which were of radial symmetry; others became dorsiventral, but were sometimes abnormally orientated. Such primordia usually underwent a phase of radial symmetry during development. Subsequent deepening of the abaxial or radial shallow incisions was usually without effect. In a discussion of the problems of leaf determination, symmetry and orientation, it is suggested that, in specimens where the isolated primordia developed as leaves, the experimental treatments have merely fortuitously reproduced the regulative effects normally exercised by the shoot apex and adjacent primordia. There may be specific relationships between the size and growth capacity of the primordium and that of the shoot apex on which it is formed. Three phases in the development of a leaf primordium of this species can now be distinguished: inception as a growth centre, determination as a foliar organ of limited growth, and development as an organ of dorsiventral symmetry. Under normal growth conditions, radial leaf development is never observed, but when growth is unusually slow it may become manifest. In other species the temporal relationships between these phases of development may differ, so that they cannot be differentiated by experimental means.

Second International Symposium on Freezing and Drying

The Institute of Biology is arranging a symposium on freezing and drying to discuss progress in this field since the first symposium held in 1951. The meeting is to be held in the Beveridge Hall, Senate House, London, W.C.1, on April 1 and 2. Some twenty speakers, including workers from France, Japan, Kenya, the United States and the U.S.S.R., have accepted invitations. The symposium will be open to the public. Further information can be obtained from the Institute of Biology, 41 Queen's Gate, London, S.W.7.

"Structure of Brain Ganglioside"

With reference to the communication under this title by Dr. Samuel Bogoch published in *Nature* of July 27 (180, 197; 1957), Dr. J. Folch-Pi, director of scientific research, McLean Hospital (Harvard Medical School), Waverley, Mass., states that Dr. Bogoch should have mentioned that most of this work was carried out at the McLean Hospital Laboratories, and that it was supported by the American Cancer Society (Grant *BCH*-11 *et seq.*).

University News: London

The British Steel Producers' Conference and the British Constructional Steelwork Association have offered £6,000 a year to the Imperial College of Science and Technology, London, for the establishment of a readership in structural steelwork in the Department of Civil Engineering and the provision of a number of bursaries for postgraduate study in that subject.

Nottingham

The title of reader in applied mathematics has been conferred on Mr. John Edward Adkins.

The Night Sky In February

Full moon occurs on Feb. 4d. 08h. 05m U.T., and new moon on February 18d. 15h. 38m. The following conjunctions with the Moon take place: Feb. 9d. 14h., Jupiter 2° N.; Feb. 13d. 09h., Saturn 2° S.;

Feb. 14d. 12h., Mars 5° S. In addition to these conjunctions with the Moon, Mercury is in conjunction with Venus on Feb. 7d. 07h., Mercury being 9·6° S. Mercury is too close to the Sun for normal observation. Venus is a morning star, visible low in the south-east before sunrise. It rises at 6h. 25m. and 4h. 55m. on February 15 and 28, respectively. Mars rises at 5h. 20m., 5h. 10m. and 4h. 55m. at the beginning, middle and end of the month, respectively; it is visible in the south-east before sunrise. Jupiter rises at 0h. 10m., 23h. 15m. and 22h. 25m. on February 1, 15 and 28, respectively; it is east of Spica, and is stationary on February 16. The stellar magnitude of Jupiter is − 1·8, its distance from the Earth on February 15 being 460 million miles. Saturn rises at 4h. 45m., 3h. 55m. and 3h. 10m. at the beginning, middle and end of the month, respectively; it is near θ Ophiuchi. It has a stellar magnitude of + 0·8 and a distance of 980 million miles from the Earth on February 15. There are no occultations of stars brighter than magnitude 6 visible at Greenwich.

Announcements

Mr. R. R. Blackwood, general manager of the Dunlop Rubber Co. of Australia, formerly professor of mechanical engineering in the University of Melbourne, has been appointed chairman of the interim Council of the new University of Victoria. It is also expected that he will be the first chancellor of the University when it becomes established (see p. 300 of this issue).

Dr. J. A. Fraser Roberts, director of the Medical Research Council Clinical Genetics Research Unit, Institute of Child Health, The Hospital for Sick Children, Great Ormond Street, London, W.C.1, has been elected president of the Royal Anthropological Institute for the years 1957–59.

Dr. M. C. R. Symons, lecturer in chemistry in the University of Southampton, has been appointed visiting associate professor in the Department of Chemistry at the University of British Columbia for the period January 1–June 30.

The following appointments in the Ontario Research Foundation have been announced: Dr. A. E. R. Westman to be director of research of the Foundation, Dr. H. B. Marshall to be director, Department of Chemistry, and Dr. S. G. Reid to be an assistant director in that Department.

The Fifteenth International Horticultural Congress will be held in Nice during April 11–18, under the presidency of M. Henri Queuille. The theme will be "Science in the Service of Horticultural Techniques". Further information can be obtained from M. le Secrétaire général du XV^{e} Congrès International d'Horticulture, 84 rue de Grenelle, Paris 7^{e}.

The fifth Easter School in Agricultural Science will be a symposium and colloquium on "The Nutrition of the Legumes". It will be held at the University of Nottingham School of Agriculture, Sutton Bonington, near Loughborough, Leicestershire, during April 14–17. Further information can be obtained from the conference secretary, Mr. E. A. N. Greenwood, at the above address.

The first international symposium organized by the International Collegium for Neuro-Psychopharmacology will be held in Rome during September 9–12. In addition to organized symposia, there will be certain sessions devoted to original communications. Those interested in presenting papers should send a 250-word abstract before March 31 to Dr. P. B. Bradley, Department of Experimental Psychiatry, The Medical School, Birmingham 15, from whom further particulars may be obtained.

The Radiation Research Visiting Club is holding a meeting in Cambridge on March 20 and 21 on the theme of the action of high-energy radiation on solids. Further details may be obtained from Dr. A. J. Swallow, Tube Investments Research Laboratories, Hinxton Hall, nr. Saffron Walden, Essex.

The South-Eastern Union of Scientific Societies is organizing a conference on conserving wild life and amenities in the south-east of England, to be held at the Zoological Society of London, Regent's Park, N.W., on April 12, under the chairmanship of the Earl of Cranbrook. Each member society is being invited to nominate two delegates to attend the discussions, which, it is hoped, will lead to the formation of Naturalists' Trusts for each county represented.

The second symposium of the Reticuloendothelial Society (New England Institute for Medical Research, Ridgefield, Connecticut) will be held in Rapallo, during August 29–31. It is intended to discuss the subject under three main headings—the reticuloendothelial system and steroids; the reticuloendothelial system and immunity, including antibody immunity and properdin, and tumour immunity; and the reticuloendothelial system and radiation. As in the first symposium, which was held in France at Gif-sur-Yvette in 1956, attendance at the symposium will be limited. Proposed titles of papers from intending participants should be sent, accompanied by a brief summary in English, before March 15, to Dr. Alberto Marmont, Clinica Medica Universitaria, Viale Benedetto XV, Genoa, Italy, to whom inquiries may be addressed.

The Medical Research Council states that in future all requests for compounds in the Steroid Reference Collection should be addressed to Dr. W. Klyne at the Postgraduate Medical School, Ducane Road, London, W.12, and not to the National Institute for Medical Research at Mill Hill. As a result of generous gifts from two industrial firms, larger supplies of œstriol and 16-epi-œstriol (Organon Laboratories) and very limited supplies of racemic aldosterone (Ciba AG, Basel) are now available; these materials are intended for chemical reference purposes, and not for clinical work.

The authors of the first article on "Controlled Release of Thermonuclear Energy", entitled "Production of High Temperatures and Nuclear Reactions in a Gas Discharge" (*Nature*, January 25, p. 217), wish to add the following acknowledgments: (1) investigations leading up to the present results have been constantly encouraged and supported by Sir John Cockcroft, Sir George Thomson and the late Lord Cherwell; (2) invaluable assistance has been given by their colleagues at Harwell and at the Research Laboratory of the Associated Electrical Industries, Ltd., Aldermaston; (3) the erection and maintenance of ZETA has been under the control of J. T. D. Mitchell, of the Engineering Division.

TECHNICAL EDUCATION IN THE U.S.S.R.

AN impressive account indicating the importance attached to technical education in the Soviet Union has been given by C. E. Simmonds in a publication of the Society for Cultural Relations with the U.S.S.R.*.

Compared with a total of 200,000 in Russia in 1913, it is claimed that there are now more than 5 million specialists with a higher or secondary education; about 280,000 specialists with higher education qualified in 1955 and entered various branches of the national economy. Each year about 60,000 'professional engineers' and 70,000 lower grade engineers are being produced; to support their activities the aim is to train two, four or more technicians with secondary schooling for every college-trained specialist. The U.S.S.R. has some 3,000 scientific research institutes, experimental stations and laboratories, and more than 900 institutions of higher education. It has 4,000 technical and other specialized secondary schools.

The system is in many ways simpler than that to be found in Britain, where qualifications depend on State examinations or the requirements of the City and Guilds of London Institute, the specialized professional institutes, the trade unions and industry itself. In the Soviet Union the minimum educational period provided is the seven-year school (seven to fourteen); ten-year secondary education (seven to seventeen) is now established in the large towns, and is to become universal by 1960. Secondary qualifications can also be gained in specialized secondary schools, or *tekhnikums*, which also train secondary school leavers as technicians, or at evening classes. Each trade has its nationally-determined 'technical minimum' and a range of grades of skill with corresponding rates of pay; there is thus a constant incentive to study.

Many workers study in the evening after work; others attend full-time short courses of training or re-training, others (up to the age of thirty-five) win places in the higher technical institutes. The Labour Reserve Ministry has a complex network of schools, and courses for training skilled workers are being increasingly used in factories where automatic processes have been introduced. The Moscow automatic ball-bearing factory is described as "the most advanced production unit of its kind in the world". It turns out 900,000 ball-races and 600,000 roller bearings a year, with a total staff of 178 divided between two shifts. It took six months to design this factory and eighteen months to build it. Some 2,000 or 3,000 designers, including many from centralized research and development agencies, were involved in its planning. The experimental Research Institute for Metal Cutting Machines in Moscow has a staff of more than a thousand scientific workers. The Ordjonikidze machine tool factory has 400 designers and draughtsmen. One Moscow factory employing 4,000 workers has more than forty full-time teachers in its own technical school. The Red Proletariat Works, in Moscow, turns out small universal lathes at the rate of 12,000 a year, using only 1,000 workers. This lathe line took eighteen months to design and build.

To produce a sufficiency of scientists and technologists, Soviet educationists insist that technical education must be broadly based. The aim of the ten-year school is to turn out boys and girls, with a certificate including Russian language and literature (in addition to the native language in the non-Russian Republics) as well as mathematics and physics as compulsory subjects (the standard of the certificate is rather above that of the General Certificate of Education, Ordinary Level), with a good knowledge of basic scientific principles and some conception of their application in industry and agriculture, with practical experience of tools and machines, and, above all, with an interest in the world around them and a willingness to use their hands and brain creatively and adapt themselves quickly to whatever job they choose on leaving school.

The new syllabuses adopted in the past few years include practical handwork and nature study in the first four classes. The course is the same for all pupils, girls and boys, without selection or streaming. The children are encouraged to link up all the subjects they study with what is going on in the community to which they belong, the industrial and agricultural processes, the local climate and geography. In classes 5–7 there are two periods of wood and metal work per week. Practical work in agriculture (linked with biology studies) and electrical technology (linked with physics) also begins at this stage. The main elements of electro-magnetism and its practical application are taught in class 7. Practical work in electro-technology begins in class 7, and continues in the next three classes. Pupils learn how to wire up simple circuits and later they deal with complex apparatus like meters and dynamos. In class 8 engineering and machine study is introduced as the third practical subject, with two periods a week allotted. The work involves theoretical and practical study of various tools and mechanisms, such as parts of cranes, lathes, drills and jacks. The pupils' knowledge is gradually built up from understanding the principles and functions of the parts, to grasping the working of complex machines such as the car and the tractor, which is a main feature in the ninth-year syllabus. Visits to factories, and periods of practical work at some enterprises, are an integral part of school work, more especially if the school has a factory acting as patron, helping with the supply of equipment, lecturers and workshop instructors. The visits take the form of excursions carefully planned and followed up. At some schools, pupils from upper forms go to work at a factory once a week during school time. They work under careful supervision in machine-repair shops, electrical laboratories and tool-rooms.

Simmonds's paper also contains an account of the Labour Reserve Scheme for training skilled workers which was set up in 1940; between 1946 and 1954

* Technical Education in the U.S.S.R. By C. E. Simmonds. Pp. 36. (London: Society for Cultural Relations with the U.S.S.R., 1957.) 2s. 6d.

more than 5 million skilled workers were trained in a variety of trades in the Labour Reserves Schools.

With the extension of ten-year schooling, it was decided, in 1954, to open a new type of two-year technical college, called a *tekhnicheskoye uchilishche*, intended for entrants who had already completed the ten-year school. Two hundred and sixty-one were opened in 1954, and by 1956 the number had grown to four hundred and forty, spread throughout the U.S.S.R. They are designed to train workers and junior technicians for highly skilled and responsible work, to take charge of machinery in rolling mills and mines, or to control automated processes and operate measuring instruments. Steam and diesel engineers, electricians and laboratory workers are being trained for agriculture. Entrance is open to young men and women from the ages of seventeen to twenty-five, local people being given preference in any given area.

Besides the products of the Labour Reserve Colleges, the aim of the sixth Five Year Plan (1956–1960) is to supply 550,000 skilled workers with secondary education from the new two-year technical colleges. The trade and railway schools will train 520,000 workers, the mining and building schools 1,180,000, and the agricultural mechanization schools 1,090,000. New schools are to be developed in Siberia, and more than a thousand million roubles are to be allocated by the Labour Reserve Organization for new schools, buildings, workshops and hostels. The schools vary from excellent to poor, the shortage of teachers and instructors, text-books, equipment and visual aids being still acute. Criticisms are made that the two-year course at the new technical colleges is not long enough, that syllabuses are overcrowded, that on-the-job training needs radical overhauling, students being often used as a reserve of extra workers.

In 1956, 1,961,000 students, internal and external, at 3,757 secondary technical and vocational schools were under the jurisdiction of various ministries. These are distinct from the general schools; their status is higher than that of the Labour Reserve Colleges, but not so high as that of a university or institute. Successful completion of the *tekhnikum* course qualifies the student to apply for entrance to higher establishments. A large number of these *tekhnikums* train skilled workers, junior technicians and supervisory staff for agriculture, engineering, mining, building, transport, but the range is very wide and includes nursing, book-keeping and commerce, finance and credit, various branches of light industry, and one special course for theatre technicians, attached to the Moscow Arts Theatre. One special type of industrial *tekhnikum* trains skilled workers as instructors in the Labour Reserve Schools. At present more than a million technicians and specialists with secondary qualifications are working in industry and agriculture. The sixth Five-Year Plan estimates that more than two and a half million students will complete these secondary technical courses.

The *tekhnikums* are staffed partly by specialist teachers from the universities and institutes, and partly by craftsmen-instructors, full- or part-time, from industry. Successful *tekhnikum* students are expected to go straight into fairly responsible jobs, not usually as craftsmen but as team-leaders, technical and laboratory assistants and assistant supervisors. In agriculture they are expected to take charge of field-work teams or sectors of farm economy. There are already three candidates for each full-time place in a *tekhnikum*; the aim is to expand the intake to double or treble the present figure.

Higher technical education in the Soviet Union includes not only all faculties of all universities but also every kind of specialized institute; it is difficult to give accurate figures for those who graduate from universities or from institutes.

While Soviet universities train science graduates, there are no university faculties for engineering or technology as such. The difference in function of universities and higher technical institutes is well expressed in the report of the British engineers who visited the U.S.S.R. in 1956. "The thirty-three universities do not offer courses in technology, and they do not contribute directly to the education and training of engineers. . . . But the universities offer courses in physics, a great deal of which is applied to engineering, and this brings them into touch with the developing branches of engineering. Physicists and mathematicians from the universities provide some of the teaching force in the institutes, and some of them are employed by industry in application work."

Students at all higher educational establishments in 1956 numbered 1,867,000, an increase of more than 100 per cent since 1941. There are now more than 900 higher educational establishments in the U.S.S.R., including thirty-three universities, and the teaching staff at these establishments is to-day more than 100,000. With its new building for the science faculties, opened in 1953, the University of Moscow has more than 18,000 students, including a number from outside the Soviet Union. In 1946, most technical colleges were brought together under the U.S.S.R. Ministry of Higher Education, instead of being under the jurisdiction of various ministries.

The age limits for admission to higher education institutions are seventeen to thirty-five but there is no age-limit for external (correspondence) students.

After graduation, the State Planning Committee of the U.S.S.R. Council of ministers allocates the year's graduates to the different ministries in accordance with the national economic plan. Posts are allocated by a State Commission which takes into account the wishes and inclinations of the student. Volunteers for work in the central eastern and northern regions are encouraged by appeals to patriotism and the pioneering spirit and also by financial inducements of 10–100 per cent additions to normal wage-rates.

Research work often begins during the undergraduate course and many students are responsible for innovations and inventions. At the Bauman Technical College in Moscow, more than 700 students were engaged in research in 1950 and fifty received certificates for their inventions. The Scientific Society of the University of Moscow has 2,200 student members who conduct research. A number of honours students proceed to postgraduate research for three years, after which they take examinations and present a thesis for the degree of Candidate of Science. The titles of successful theses are published in the specialized journals every year. In 1952, 25,000 postgraduate students were being trained at higher educational establishments and research institutes.

The system of studying as external students, by correspondence or at evening classes, is widespread and forms an integral part of the higher education network. There are twenty-two higher educational correspondence institutions with a large number of branches, and 393 correspondence and 211 evening departments. More than half a million men and women are studying by this method. Correspondence students have short periods of practical work, lectures and examinations each year.

RADIOISOTOPES AND GLASS

A SYMPOSIUM on the subject "Radioisotopes and Glass" was held by the Society of Glass Technology at the Department of Glass Technology of the University of Sheffield on November 27. Dr. W. M. Hampton was chairman of the morning session, followed by the president of the Society, Mr. C. E. Ramsden, who took the chair in the afternoon.

In an introductory lecture, Mr. J. L. Putman (Atomic Energy Research Establishment, Harwell) directed attention to the dual nature of the discussions, in dealing with both the services which radioactive techniques can offer to the glass industry and the demands which the handling and measurement of radioactive materials make upon glass. He mentioned the use of glass for containers and remote-control manipulative equipment for use with radioactive solutions, the use of lead glass as a transparent screening material for operations with high gamma-ray intensities and the use of discoloration as an index of high gamma-ray doses.

Following a brief review of the nature and properties of radioisotopes, Mr. Putman indicated the main ways in which these materials could be used, as radioactive tracers in solid, liquid or gaseous form, as sources of radiation in non-contacting thickness and density gauges, and as dissipators of unwanted electrostatic charges on insulators. A particular note was made of the special role of glass in the construction of Geiger counters and other radiation detectors.

Mr. E. W. Jones (Isotope Developments, Ltd.) spoke on "Glass Level Measurement in Furnaces". After a brief review of orthodox measurements of glass level, he pointed out the advantages of a radioactive system which does not require access to the inside of the containing vessel.

He referred to an early French design using radium as the source, and described a more recent British installation for monitoring the level of molten glass in the feeder to a bottle-making machine. In this model, which operates through two brick and refractory walls each 9½ in. thick, encased in ⅜-in. steel, a cobalt-60 source of activity 200 mc. is used in conjunction with a water-cooled, all-metal Geiger counter as detector. Indications of changes in glass level up to ± ¼ in. are obtained, with a sensitivity of about ± 0·01 in. Gradual radioactive decay is compensated by increasing the electronic sensitivity, so that the cobalt-60 source (much cheaper than radium) can be used over a period of five years. About one hundred such instruments are now installed, but only a few employ the desirable feature of automatic control by servo adjustment of the screw feed.

Mr. Jones outlined other possibilities for using simple level gauges to operate high-level warning systems, on batch silos and hoppers, and also mentioned the possibilities of using thickness gauges for the inspection of bottles and sheet glass.

Dr. R. E. Bastick (Chance Brothers, Ltd.) described the "Development of Glasses for Use with Radioisotopes and other Sources of Radiation", with particular reference to their uses for screening. He outlined the calculation of lead equivalent and showed that experimental determinations of this are in agreement within 1 or 2 per cent. Lead equivalents up to 0·6 were reported for some lead glasses.

Dr. Bastick then discussed the coloration of crown and flint screening glasses by large doses of radiation and showed results of doses up to 10^7 r. on flint glass and the subsequent fading observed. The use of cerium oxide as an additive to inhibit coloration was described, with data showing the inhibitory effect of various quantities of cerium dioxide in flint glass at a total dose of 10^7 r.

Neutron absorbing glasses containing oxides of cadmium and boron were described, and the dependence of absorption coefficients on neutron energy was shown.

A brief account of the use of a lead glass scintillator in a Cerenkov counter was given, and the use of cobalt loaded borosilicate glass for gamma-ray dosimetry was described.

In discussion on this paper, the special property of quartz glass in withstanding gamma-radiation up to 10^8 r. without coloration was mentioned, and the purple coloration produced by radiation when 4–6 p.p.m. of aluminium is incorporated was proposed for dosimeters which show little or no fading. It was also noted that denser glasses required smaller concentrations of cerium dioxide to inhibit coloration (for example, plate glass requires 2 per cent, while lead glass needs only ½ per cent).

Mr. J. L. Putman (Atomic Energy Research Establishment, Harwell) then presented a short paper on the "Determination of Selenium in Glass by a Radioactivation Method", an investigation made in collaboration with the British Glass Industry Research Association. He remarked that in finding the retention by glass of selenium added as a decolorizer, colorimetric methods were not applicable because of their dependence on the chemical form of the sample, and chemical analysis was cumbersome. In the method described the simultaneous neutron irradiation, in a reactor, of glass samples with and without the selenium additive was followed by comparison in a differential gamma-ray spectrometer, which subtracted the response of one sample from another, leaving only the gamma-ray spectrum due to selenium-75. Determination was thus specific for the element and largely independent of other impurities. Concentrations of 19·5 p.p.m. were measured with an estimated accuracy of ± 5 per cent. The applicability of the technique to analysis of other constituents and to the use of non-radioactive tracers was suggested.

In the afternoon, Mr. B. E. Moody (United Glass Bottle Manufacturers, Ltd.) described an "Investigation of Glass Flow in Furnaces by Radioactive Tracers". To trace the flow through furnaces handling 90 tons a day, over a period of 12–14 days, phosphorus-32 was chosen as the tracer, thus avoiding radiation hazards from the high activity of radioactive glass in the furnace, since it emits only beta particles. The tracer was in the form of neutron-irradiated ground phosphate glass compatible with the melt, and contained 51 per cent phosphorus pentoxide. After a delay of one week to allow radioactivity of potash and alumina constituents to decay, the phosphate glass contained 2 mc./gm. of phosphorus-32. It was added to the feed of one or more

of three batch chargers over a period of ½ hr. From 35 to 350 mc. of phosphorus-32 was used in an investigation, 175 mc. being found to be the optimum activity.

Samples were taken at intervals from the output of three bottle-making machines fed by the furnace and measured with an end-window Geiger counter. By using a metal iris to limit the area inspected by the counter and by using glass samples thicker than 3 mm., it was established that the shape of the samples did not critically affect the results, and pieces of bottles were conveniently used for measurements.

It was found that tracer added to one of the outside batch chargers appeared almost uniformly in the three bottle-making machines, indicating good mixing and absence of streaming in the furnace. After a delay of 7½-10 hr. for amber glass and 5–6 hr. for flint, radioactivity began to appear in the product, reaching a maximum in about 24 hr. This was followed by a nearly exponential decay, leaving only 1·4 per cent of the labelled glass after 12 days and undetectable activity after 14 days. Apart from the expected initial delay before marked constituents appeared in the product, agreement with the 'curve of perfect mixing' was fairly good. Some subsidiary peaks in the curve of activity versus time were unexplained, but some were believed to be due to the recycling of active cullet.

Mr. R. F. Barker (Pilkington Brothers, Ltd.) gave an account of an "Investigation of Glass Flow in Furnaces by Radioactivation Methods". The furnace described was producing 6·4 tons per hr. of soda lime silica glass and had a capacity of 1,350 tons. Measurements were required over a period of several weeks. The long half-life and high activity required in a radioactive tracer made the use of radioactivity in the furnace undesirable. Hence an inactive material which could be made radioactive by the subsequent neutron irradiation of samples was used. Tantalum was chosen because of its high neutron cross-section and the desirability of the gamma-emitting tantalum-182 formed on neutron irradiation, the half-life (110 days) of which was longer than that of any activity induced in the normal constituents of the glass. The tracer was in the form of 3¾ kgm. of tantalum peroxide.

Tests were made on three of five machines fed by the furnace, and 200 samples, each containing 5 gm. of powdered glass, were irradiated in a reactor at Harwell. After a delay of five weeks to allow short-lived activities to decay, measurements were made with a scintillation counter, using a single-channel pulse amplitude analyser to distinguish the tantalum-182 gamma rays. A minimum transit-time of 4 hr. was found, in agreement with other data. The tracer was at a maximum after 100 hr. and its decline was followed over a total time of 520 furnace-hours. Moderate agreement was found with W. M. Hampton's theoretical curve for perfect mixing, but Mr. Barker directed attention to significant departures from this curve near the time of injection.

In a second paper, on "The Assessment by Tracer Methods of Mixing during Sand Treatment", Mr. R. F. Barker described experiments made in collaboration with the Isotope Division, Harwell, using sand labelled by immersion in a solution of barium-140 and subsequent heating at 500° C. The adhesion of the radioactive material was already established under conditions of abrasion and washing with water. The daughter isotope lanthanum-140 (40 hr.) reaches equilibrium with the barium-140 (12 days) and measurements were made of gamma rays from the lanthanum.

Ten pounds of labelled sand, carrying 100 mc. of barium-140, were mixed with 5 cwt. of inactive sand in a cement mixer and added to a hopper feeding the washing plant. The progress of the radioactive material through the washing plant and grader was registered by recording meters placed outside the steel pipes carrying the sand slurry. A survey was made of the horizontal distribution of radioactively labelled sand in the storage bin (capacity 2,000 tons). At this stage the labelled sand was found still to be fairly localized. Further monitoring of the sand leaving the bin and in the railway transit wagons showed that mixing was introduced by the method of loading.

Finally, timed measurements were made of the radioactivity of glass drawn off from the tank furnace. From an analysis of these results the distribution of a particular sample of the original sand in the finished product was assessed.

The papers were followed by lively discussion. The proceedings of the symposium will be published in the *Journal of the Society of Glass Technology*.

J. L. PUTMAN

MELTING AND DIFFUSION

THE second symposium on "Melting, Diffusion and Related Topics" was held at the National Research Council Laboratories, Ottawa, on October 21–22. The meeting was sponsored by the Low Temperature and Solid State Physics Group of the Division of Pure Physics, National Research Council of Canada. As in the previous symposium, reported in *Nature* (177, 23; 1956), the object was to bring together workers with varied approaches to the subject and, by limiting the number of formal contributions to twelve, to encourage informal discussion.

In the previous symposium the melting process itself was a major topic of interest. In contrast, the programme on this occasion was concerned chiefly with processes having only a general bearing on melting, the direct approach being temporarily abandoned in favour of seeking clues from the solution of associated problems.

Among the papers concerned with measurements in the region of melting was one by D. L. Martin (National Research Council), who reviewed existing information concerning specific heat anomalies in the region of melting; he showed that both anharmonicity and lattice defects have been invoked in explanation but argued that little conclusive evidence exists as to their relative importance. N. H. Nachtrieb (Institute of Metals, Chicago) dealt with diffusion in liquid and solid pure metals and in alloys; the analysis of his measurements showed a clear relation between melting and diffusion parameters, but also underlined the restricted nature of purely thermodynamic arguments. Diffusion was also considered

by J. A. Morrison and R. Rudham (National Research Council), who gave details of their identification of the mechanism of the anion diffusion process in sodium and potassium chloride crystals. Slow neutron diffraction measurements were described by a group of workers from Chalk River: D. G. Henshaw and N. K. Pope gave complementary experimental and theoretical accounts of the determination of the radial distribution function in solid and liquid helium and neon and in liquid argon, while B. N. Brockhouse showed how the incoherent scattering could give information on molecular motions and may provide a means of resolving some of the indeterminancies involved in the direct measurement of diffusion.

A second group of contributions dealt with transitions other than melting. R. W. Smith (University of Toronto) described investigations on the grey tin/white tin transformation carried out in Birmingham with G. V. Raynor, in which previous uncertainties of observation have been positively correlated with impurity content. D. Gugan and J. S. Dugdale (National Research Council) gave a preliminary report of work in which electrical resistivity measurements appear to provide information on the martensitic transformation in lithium. Z. S. Basinski (National Research Council) outlined a theory of work hardening of face-centred cubic metals in which the main obstacles were provided by the 'forest' of dislocations; the theory appeared to apply also to body-centred cubic metals, but in that case at low temperatures the mechanical properties were dominated by a large Peierls–Nabarro force. Work on the liquid state was represented by an account given by A. C. Hollis Hallett (University of Toronto) of recent experiments on the viscosity of liquid helium.

The single contribution dealing specifically with melting was by J. S. Dugdale, who discussed the Lindemann melting formula in relation to inert gas solids. R. J. Uffen (University of Western Ontario) once again made a convincing defence of large-scale approximation and extrapolation, this time discussing certain tectonic and volcanic phenomena in terms of the pressure dependence of melting of various types of magma.

In these days of high-speed conferences it is pleasurable to report on one at which the pace and length of discussion were such as to enable at least one non-expert to participate with profit. An informal report of the proceedings is in preparation.

J. W. Leech

ELECTRONICALLY EXCITED SPECIES

A SYMPOSIUM on "The Structure and Reactivity of Electronically Excited Species" was held at Ottawa during September 5–6 under the auspices of the Physical Chemistry Division of the Chemical Institute of Canada.

In his introduction to the section on structure, G. Herzberg directed attention to the rapid increase, recently, in the number of polyatomic molecules, radicals and ions for which rotational and vibrational analyses of electronic systems had been carried out. This had demonstrated that, in many cases, the shapes in the excited states are different from those of the ground-states. For example, acetylene, hydrogen cyanide and carbon disulphide are linear in their ground-states but bent in their first electronically excited states. Throughout the meeting it was clear that the predictions made by A. D. Walsh in 1953 had been substantiated most impressively. References were repeatedly made to Walsh's energy diagrams.

G. W. Robinson and V. E. DiGiorgio showed in a submitted paper that formaldehyde is non-planar in a low-lying excited state, while K. Allison and A. D. Walsh concluded that the same may be true for one or two of the excited states involved in the Rydberg transitions. G. W. King presented evidence for the conclusion that there is only a small change in molecular geometry on exciting the glyoxal molecule in the transition studied by him.

During this part of the meeting much interest was shown in the interactions between electronic and vibrational motions of polyatomic molecules. M. H. L. Pryce, U. Opik, H. C. Longuet-Higgins and R. A. Sack dealt theoretically with the dynamical Jahn-Teller effect, considering the energy-levels of a non-linear molecule in a doubly degenerate electronic state which is split by a doubly degenerate vibrational mode. K. Dressler and D. A. Ramsay dealt with the Renner effect in linear molecules. The lowest state of linear NH_2 would be a Π state. Experimental results suggest that the ground-state is bent and the first excited state is linear, the vibrational levels of the hypothetical linear state correlating with the levels of those two states, half with those of the excited and half with those of the ground-state. The ground- and excited states are degenerate when the radical is linear but different in energy when it is bent. The radical HCO appears to behave similarly.

Two papers by J. N. Murrell and by D. S. McClure were submitted which discussed the transfer of electronic and vibrational energy between weakly coupled systems. This is a subject of very great interest at the moment.

In addition to molecules and radicals the excited states of ions were discussed during the meeting. D. C. Frost and C. A. McDowell described their mass spectrometer which has been employed to determine the energies of the excited states of the ions produced in the instrument. This complements information that can be obtained spectroscopically, though so far detailed analyses of polyatomic ionic spectra are only available for CO_2^+, CS_2^+ and $C_4H_2^+$. Also J. W. Sidman, in an interesting paper, described results obtained for the nitrite ion in the crystalline state. From these he obtained information concerning the vibrational and lattice frequencies of the ground- and excited states.

There is doubt about the multiplicities of the excited states of some molecules and, in this connexion, A. E. Douglas presented some results for the Zeeman effect in the near ultra-violet bands of carbon disulphide. This indicates that the excited state is a triplet. G. W. Robinson and V. E. DiGiorgio concluded that the weak bands of formaldehyde studies by them were due to a singlet–triplet system.

On the theoretical side R. S. Mulliken suggested that it may soon be possible to make more reliable calculations of the energies of excited molecular states. He presented results for carbon monoxide, nitrogen and acetylene and for several molecules of the AB_2 type. The possibility of chlorine dioxide in the excited state being unsymmetrical was discussed, since the antisymmetric vibration appears to be excited on going to the upper state. J. W. Linnett discussed the electron distribution in the ground- and low-lying excited state of acetylene by transforming the molecular to equivalent orbitals. On this basis it was possible to understand why the carbon–carbon bond-length in the excited state is about the same as that in the ground-state of benzene and why the molecule is bent.

E. W. R. Steacie gave the introductory paper to the section on reactivity and pointed out that, while the evidence for excited species occurring in chemical processes had in the past often been very meagre, firmer knowledge of their participation in reactions is now being obtained. H. Eyring also gave a broad survey of the field and stressed the value of potential energy surfaces when considering chemical reactions theoretically.

There were several interesting theoretical contributions to this section. R. A. Marcus considered the case of electronically excited molecules reacting unimolecularly, the course of reaction being examined as motion on a potential energy surface. B. Stevens pointed out that while totally symmetric vibrations are excited when an electronic transition occurs, the excitation of non-totally symmetric vibrations are usually necessary for dissociation. A transfer of energy must therefore occur, and this will depend on the anharmonicity. Stevens suggested that the dissociation rate will consequently depend on the magnitude of optical energy taken up. E. K. Gill and K. J. Laidler discussed theoretically the reaction :

$$Hg^*(^3P_1) + O_2(^3\Sigma_g^-) \rightarrow Hg(^1S_0) + O_2^*$$

They reached the conclusion that both the theoretical and experimental evidence leads to the view that oxygen is produced in the $^3\Sigma_u^+$ state. This involves the minimum transfer of energy from one form to another. Potential energy surfaces were used by these authors also.

H. E. Gunring described experiments which made use of a mercury-vapour lamp charged with mercury-202. With this, mercury-202 could be excited in ordinary mercury vapour in the presence of gases with which the excited mercury could react. Isotopic enrichment in a solid product indicated that this was formed in a primary process ; no enrichment indicated that it was formed secondarily. No enrichment in mercuric oxide was obtained from nitrous oxide and oxygen but enrichment in mercurous chloride was found with hydrogen and methyl chlorides and with carbon tetrachloride.

J. D. McKinley and S. C. Polanyi had mixed atomic sodium with atomic and molecular hydrogen. They discussed the reactions that might lead to the chemiluminescence (sodium D lines) that is observed. J. C. Polanyi and also C. L. Arnot and C. A. McDowell discussed the results they had obtained for the rate of transfer of vibrational energy to translational when iodine is excited by the mercury green line to the twenty-sixth vibrational level of the excited state in the presence of inert gases. The competition between energy transfer and fluorescence is studied. Arnot and McDowell found that the ratio of rates was greater than expected from theory and suggested that the fluorescence lifetime may be less than has been supposed.

T. M. Sugden and E. M. Bulewicz and also F. Kaufman described work on the green emission that is obtained when nitric oxide is added to systems containing oxygen atoms. The former workers concluded that the intensity of the glow is determined by a more complicated process than the simple combination of atomic oxygen and nitric oxide.

G. J. Minkoff discussed the polymerization of acetylene and considered the possibility that a bent triplet diradical might be involved in the mechanism.

H. P. Broida and K. E. Shuler described the use of the reversal of iron lines in studying flame temperatures. This proves to be a sound method if equilibrium is established. Moreover, it is possible to discover when equilibrium is not established. P. Carrington had studied the emission by $^2\Sigma$+OH radicals in oxy-acetylene flames. It appears that the electronically excited radicals are deactivated at nearly every collision, so any departure from the equilibrium distribution that is observed must represent the situation prevailing on the production of the excited radicals.

J. Heicklen and W. A. Noyes described photochemical experiments that had been carried out with ketones and bi-acetyl. In the latter case they concluded that triplet excited molecules were involved. They discussed the decomposition, fluorescence and phosphorescence of these substances. H. Okabe described work on the fluorescence and photolysis of hexafluoroacetone. The effect of pressure and the addition of foreign gases was studied.

J. W. LINNETT

SUPPLY AND DEMAND

PROF. M. G. Say delivered his chairman's address before the Supply Section of the Institution of Electrical Engineers on October 23. The address, which was given under the title "Too Much and Too Little", was by no means confined to strictly technological considerations, and constituted, rather, a broad philosophical review of the persistent disparity between demand and supply, between needs and resources. Commenting on the use of the figure representing the power available per head of the population as an index of the standard of civilized life, Prof. Say remarked that in North America, Western Europe, and the Soviet Union, energy resources were being developed as fast as practicable, while in the underdeveloped countries—representing three-quarters of the habitable world and two-thirds of the world's population—the demand for auxiliary energy was beginning. With the development of nuclear energy the production of electric power, which until now had been dependent upon coal, oil, or water-power, had become largely independent of geography or geology. It must, however, be remembered that a country might remain poor and underdeveloped because poverty put out of reach the

opportunity to build up the supply of power which would enable development to take place.

The total world consumption of power in the year 1950 was some 30,000 million kilowatt-hours. On a United Nations estimate of the annual rate of increase of power consumption at 3½ per cent the year A.D. 2000 would see a three-fold increase on the present demand for power. This must be met very largely from nuclear energy, for by that time coal and oil outputs would be well past their peaks and hydro-electric power would be approaching its full development. It should be noted that the present methods of generating electric power, by means of a thermal cycle, were inherently wasteful, nearly four-fifths of the available heat being rejected. If this rate of loss should continue the world would in fifty years' time be wasting heat in the production of electricity at a level in excess of twice the present total world consumption of power.

Referring to engineering as a career and to the present shortage of engineering graduates, Prof. Say drew a comparison between the situation in the U.S.S.R. and in Britain. It was worth noting that despite the scale of the Russian need for engineers and scientists there was no extreme specialization in science in the secondary schools. In the U.S.S.R. the three final years of school, to age seventeen, included the study of physics, chemistry and mathematics for about 40 per cent of the time, and this held for all pupils, arts as well as science. Thus potential arts men had to pass examinations in science subjects while potential engineers and scientists had to study literary subjects to a level quite beyond that of the average British technical student.

The concluding section of Prof. Say's address was concerned with the ultimate values in human life and the possible threat which was offered by the pressure and strain of a mechanistic age to the qualities of imagination and creation which were key elements in the human make-up. "We cannot deny," he said, "that the threat exists, nor on the other hand that industrialization has brought great benefits to mankind. It will bring more, but only if the mastery remains where it belongs—in the care of the human spirit."

J. Greig

NATURAL HISTORY OF THE FOX SQUIRREL

A FIELD study of the fox squirrel (*Sciurus niger*) in the south-eastern coastal area of the United States has been made by J. C. Moore (*Bull. Amer. Mus. Nat. Hist.*, **13**, Art. 1). The fox squirrel has probably diminished greatly in numbers and range because of changes wrought by man. *Sciurus niger shermani* was investigated in the sand hills of north Florida in a fir-maintained plant community which is common over a wide area of the south-eastern coastal plain, the *Pinus australis–Quercus laevis* associates. This plant community was changed suddenly and radically from a tall but very open forest of primeval long-leaf pines with turkey oak indifferently represented as a secondary, lower level dominant, to a virtually pure stand of turkey oak, relatively close-ranked and low.

Moore's inquiry was designed to determine how this large tree squirrel, after presumably evolving in the open stands of large pines, lives now in the lowly oak forest which has succeeded the logged-off pine.

The principal predatory enemies of *Sciurus niger shermani* are apparently the bald eagle, the red-tailed hawk, and man. There are few suitable refuges for so large a tree squirrel in this low, open forest of deciduous trees and this may have brought about the following developments in behaviour unusual for a tree squirrel: a fairly well-established tendency for it to take refuge, when hard pressed, in the burrows of gopher tortoises underground; the use by the fox squirrels of hollows that extend down through the tops of old stumps to nesting chambers underground; an escape behaviour, which may have developed since the removal of the old pines and which is presumed to be employed only against man, that involves hiding in the top of a second-growth long-leaf pine by ascending the plume-like apical twig so that the twig bends over horizontally under the squirrel, and the squirrel lies on top hidden from all below; there is, apparently, an excessive number of leaf-nests per individual squirrel, thus providing more refuge.

While these forms of behaviour have survival value, they do not enable the animal to prosper.

THE BRITISH COUNCIL

THE annual report of the British Council for 1956–57 refers briefly to the review of Overseas Information Services made by Dr. C. Hill. The decisions recorded in the White Paper accepted about nine-tenths of the Council's proposals for increased activities and the Council specially welcome the reference to co-operation with people and interests outside the Government. The Council's work depends largely on the help and advice of many educational, professional, scientific and industrial bodies as well as of thousands of individuals. About half the report deals with the Council and the sciences and an increasing proportion of the Council's work consists of making known British scientific achievement, assisting the dissemination of information to the appropriate specialists and in serving as a link between British experts and professional bodies and their opposite numbers abroad. Allied to this is assistance in training. Since 1950, the number of overseas students in the United Kingdom has risen from 10,000 to nearly 35,000, about a third of whom are at universities or university colleges, while 60 per cent are concerned with the sciences. By far the largest increase in students is among those attending technical colleges, and the numbers might be greater still if their countries could find the necessary funds or Britain could offer scholarships and places on the scale of some of her competitors.

The report stresses Britain's advantage, shared with the Commonwealth and the United States, in the establishment of the English language among scientists as an essential means of communication, and the Council's work in furthering the study of English is thus of importance in this connexion. The

University of Edinburgh inaugurated its new School of Applied Linguistics in October 1957. This is conceived especially for those who are responsible for training teachers of English and the establishment or revision of teacher-training methods. Three Council officers are participating in the course together with experts in teaching English from overseas invited by the Council. English language teaching now occupies so important a place in the Council's activities that the English Studies Advisory Committee has been divided into two separate panels, one advising on literature and the other on language.

In fostering the knowledge of British scientific achievements, the Council's special function is to use its staff in the field to find out what demands for information and training are being left unsatisfied and to put learned institutions and individual scientists overseas in touch with the appropriate organization or individuals here. Even within the Commonwealth the established links are not always adequate and the Council has been able to reinforce them by, for example, the exchange of delegates between the British Association and the corresponding organizations in Ceylon, India and Pakistan, by showing medical films in the more advanced Colonies, sending lecturers on such subjects as the use and local manufacture of laboratory apparatus, or enlisting the help of specialists who happen to be visiting the territories.

The Council's most important role in the sciences is in promoting visits by scientists to and from Britain for discussion, observation and study, and of all the visitors to Britain for which the Council makes arrangements about 13 per cent are financed by the Council. In the past five years the Council has assisted in some 7,000 visits of individuals in the sciences, or about 32 per cent of the total for all subjects. Of the Council's postgraduate scholarships, 594 or 56 per cent of the total in the past five years went to the sciences, and for the 221 awards in 1956–57 there were 2,500 applicants. The Council is also the national supervising agency for the United Nations Technical Assistance Administration Fellowship Scheme and other Fellowship Schemes of the Specialized Agencies under which 2,941 Fellows have visited the United Kingdom during the past ten years, of whom about two-thirds were concerned with science and technology, medicine, agriculture and training leading to development. Among the short-term visitors, the proportion whose interests lie in science has increased since 1950 from 25 to 30 per cent, but among the bursars it has increased from 25 to 40 per cent. There have been few changes in emphasis as regards subject, though interest in the nuclear sciences has grown and the organization of technical education has greatly increased, while the steadily growing demand for British professors, lecturers and teachers is reflected in the number of rectors of overseas universities, senior officials of Ministries of Education, and principals of teacher-training colleges who have sought the Council's help, first to study the organization of research in Britain and our methods of teaching scientific and technical staff, and then in recruiting British staff for their own institutions.

The Council operates two schemes for the interchange of university teachers, one dealing with Western European countries and the other with the Commonwealth, under which 161 scientists from United Kingdom universities have visited thirteen European countries and 62 have visited Commonwealth countries. There have been 154 reciprocal visits from foreign countries and 200 from the Commonwealth, the percentage of all these visits devoted to the sciences being 60. Under the interchange scheme for younger research workers started in 1954 there have been 33 visits from the United Kingdom to four European countries and 27 visits from these countries to the United Kingdom. Stress is also laid on the lecture and advisory tours of specialists which the Council organizes in co-operation with overseas countries, and in 1956–57 the Council initiated a pilot project to enable British experts to visit and work in Latin American universities and research institutions under which four such visits were arranged between July 1956 and March 1957. During the past five years the Council has accepted responsibility for recruitment to some forty vacancies for British scientists in teaching posts in universities and schools, but not all these have been filled.

More than 6,000 British papers from learned periodicals were supplied in 1956–57 and more than 400 specialists from some 70 countries visited the Council's medical and science libraries. Noteworthy among the group exchange visits with the U.S.S.R., arranged by the Soviet Relations Committee of the Council, were the exchanges of delegations between the Royal Society and the U.S.S.R. Academy of Sciences; between the Royal College of Surgeons of England and the Royal College of Surgeons, Edinburgh, and Russian surgeons; and exchanges of delegations interested in engineering education and training, whose programme in Britain was organized by the major engineering institutions. These visits, as Sir David Kelly emphasizes, were in marked contrast to others, non-reciprocal, since the Soviet delegations were interested simply in acquiring technical information.

DIAMONDS IN SIBERIA

By Prof. S. I. TOMKEIEFF

UNTIL quite recently no diamond deposits in the territory of the U.S.S.R. were known, while at the same time the rapid progress of industrialization was pressing for a supply of industrial diamonds, which had to be imported from abroad. This prompted the Soviet Government, through the appropriate channels of the Geological Survey, the Ministry of Geology and the Academy of Sciences, to embark on a series of planned explorations for diamonds. In 1941, diamond placers were discovered in the Urals, but these proved to be of no commercial value. In 1944 the wild tracts of taiga, situated between the rivers of Enisey and Lena, were selected as a possible diamantiferous region, and this selection proved to be a correct one, for in 1948 diamond placers were discovered in the basin of Nizhneya Tunguska, in 1949 in the basin of Vilui, and finally in 1954 the first kimberlite pipe, named 'Zarnitza', was discovered in the basin of Daldyn, in the north-west Yakutia. Subsequent explorations and prospecting greatly

extended the diamantiferous area situated between the Enisey and Lena.

This work, which began during the War, was carried out in an atmosphere of secrecy, and no results were published in scientific periodicals. Only recently, when rumours about Siberian diamonds began to be more persistent, has a popular account of the results of this exploration been published (V. S. Trofimov, *Priroda*, No. 7, 10; 1957). This article, published in a Russian popular science journal, gives a clear and comprehensive account of the diamond fields of Siberia, and is provided with a map showing the distribution of the deposits and illustrated by numerous photographs including two colour photographs of kimberlites.

The diamantiferous province is situated in the Central Siberian Plateau. Its approximate boundaries form a rectangle, 400 km. by 1,500 km. in size, stretching in a north-easterly direction from the River Angara in the south, to the River Lena between Muna and Vilui in the north-east. The whole of this area is situated in the region of taiga (north coniferous forest zone), which has a permanently frozen ground, severe climate and a very sparse population. The exploring and prospecting were mainly along the water courses at first. Operations included sampling alluvial deposits, mapping out placers and tracing pay streaks to their sources—the kimberlitic pipes. In this way several dozen kimberlite pipes were discovered in the north-western Yakutia, the only region where commercial diamonds were found both in the pipes and in the placers. The pipes pierce limestones, dolomites and marls of Cambrian and Ordovician times, but fragments enclosed in them suggest that they are of Jurassic or Cretaceous origin. All the pipes are found in a belt 1,000 km. long, 250 km. wide at the northern end and 35 km. wide at the southern end. Kimberlite is a brecciated rock containing fragments of various rocks, and crystals of pyrope, olivine, chrome-diopside, ilmenite and other minerals, including the rare diamond, but Siberian kimberlite contains little phlogopite. The pipes are oval or irregular in cross-section, with a diameter varying from 50 m. to 550 m. The usual zoning from 'yellow ground' to 'blue ground' and finally to 'hard-bank' kimberlite is rather poorly developed, probably because of the severe action of the frost, which disintegrated the solid rock of the ground water level. In some pipes several intrusive phases of kimberlite are present; for example, in the pipe 'Zarnitza' there are five columns of kimberlite, each successive phase enclosing fragments of the previous phase. The yield of diamonds from kimberlite pipes is sometimes higher than 1 metric carat per cubic metre.

Towards the end of 1956 the following groups of Yakutian pipes were located: Malo-Batuobinskaya (middle course of Irelyakh, left tributary of Malo-Batuobi, tributary of Vilui), Daldynskaya (basin of Daldyn, left tributary of Markh), Alakitskaya (upper reaches of Alakita, right tributary of Olenek), Munskaya (upper reaches of Muna, left tributary of Lena), Olenekskaya (middle and lower reaches of Olenek).

The diamantiferous alluvial deposits adjoining the kimberlite pipes in the north-eastern part of the province contain pay placers, but those of the south-western part of the province, presumed to be originally of a Pre-Cambrian age, are of no commercial value. The yield of diamonds in placers varies from 0·01 carat to several carats per cubic metre. The richer placers are situated in the basin of the Vilui River.

Siberian diamonds are rather heterogeneous both in their size and in their quality. Every region is characterized by certain types of diamonds. In size they vary from a fraction of a carat to 32·5 carats, but stones above 0·5 carat are rare. The bulk of stones extracted are less than 0·1 carat in size. The average for all stones hitherto extracted is 0·07 carat. The majority are colourless. Coloured stones (yellowish-brown, smoky, and rare greenish and pinkish) are found in the south-western part of the province. Inclusions of graphite, olivine, pyrope and small diamond crystals are often found in Siberian diamonds. Their quality is not very high. Stones of gem quality form 9–38 per cent of the total, the remainder being industrial diamonds.

No figures, as yet, are given relating to annual production, methods of working, or industrial applications of Siberian diamonds.

Additional information relating to the kimberlite pipes is provided by L. N. Leontiev and A. A. Kadensky (*Doklady Akad. Nauk S.S.S.R.*, **115**, 368; 1957). The age of pipes is definitely fixed as Triassic, more or less contemporaneous with the wide-spread intrusions and extrusions of basalt and dolerite belonging to the series of the so-called 'Siberian Traps'. The great depth, of a few kilometres, of the foci of explosions of the pipes suggests that the kimberlite is not derived from the periodotite mantle of the Earth, but is genetically connected to the alkaline variety of basic magma. The grouping of pipes suggests that they are placed along certain important tectonic features of the Earth's crust, such as flexures and tectonic breaks.

ADENOSINE TRIPHOSPHATE METABOLISM IN THE RABBIT ERYTHROCYTE *IN VIVO*

By Dr. BERTRAM A. LOWY, Dr. BRACHA RAMOT and Dr. IRVING M. LONDON
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ADENOSINE triphosphate is known to play a key part in the metabolism of many cells, including the erythrocytes of numerous species. It serves as a source of energy and as an essential component of many biosynthetic reactions and participates in co-enzyme synthesis. Although the active turnover of the labile phosphate groups of adenosine triphosphate has been investigated[1], little is actually known concerning the turnover of the remainder of this molecule. Knowledge of the biochemical origin and metabolic behaviour of adenosine triphosphate within the erythrocyte may provide some insight into the mechanisms which determine the life-span of this cell.

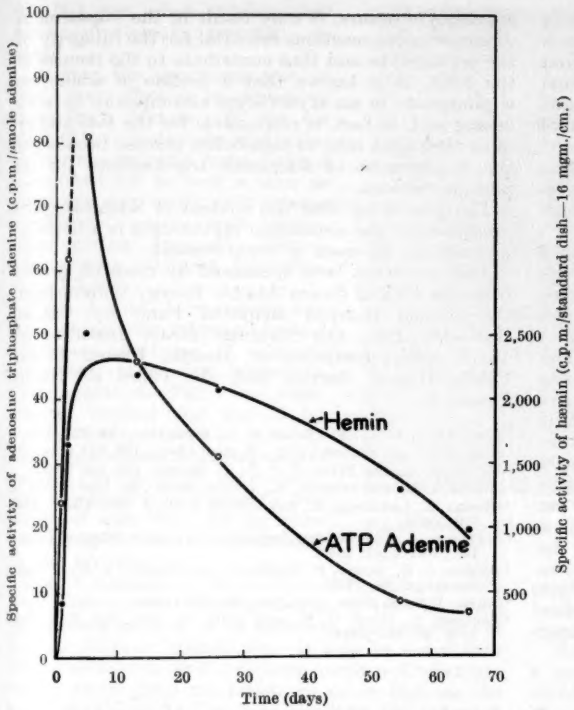

Fig. 1. Incorporation of glycine-2-^{14}C into the adenine moiety of rabbit erythrocyte adenosine triphosphate and into the hæmin of hæmoglobin

The synthesis of the adenine portion of rabbit erythrocyte adenosine triphosphate *in vivo* has been studied in order to determine the extent to which the purine moiety arises from glycine-2-^{14}C, a known precursor of purines. The metabolic behaviour of this adenine moiety has been investigated in terms of whether it resembles hæmoglobin in its metabolic stability[2,3], or is more closely related to cholesterol[4] or glutathione[5], which have been found to undergo turnover during the life of the human erythrocyte.

A number of white male New Zealand rabbits received single subcutaneous injections of 1·0 ml. of glycine-2-^{14}C in 0·9 per cent sodium chloride solution containing 0·2 millimole per ml. with a specific activity of 1·0 millicurie per millimole. After periods of time ranging from 24 hr. to 66 days, one or two rabbits were heparinized and bled by heart puncture shortly after intraperitoneal administration of 2·5 ml. of 25 per cent magnesium sulphate solution. Hind-leg muscles were removed for adenosine triphosphate preparation, and nucleic acids were isolated from the internal organs. These aspects of this work will be reported in detail elsewhere.

Erythrocytes were washed three times in cold 0·9 per cent sodium chloride solution after removal of the plasma and buffy coat. The final sample of erythrocytes had less than 0·01 per cent contamination with white cells.

Adenosine triphosphate was extracted with cold trichloracetic acid, and the barium salt was prepared[6]. The barium precipitate also contained adenosine diphosphate, adenosine monophosphate, sugar phosphates, phosphoglyceric acids and inorganic phosphate. Partial purification of the adenosine triphosphate was effected by ion exchange chromatography on 'Dowex-1-Cl' resin[7]. A mixture of adenosine triphosphate and 2,3-diphosphoglycerate, free of the other constituents of the barium precipitate, was eluted by 0·06 *N* hydrochloric acid. The adenosine triphosphate was hydrolysed with *N* hydrochloric acid by heating for 1 hr. in a boiling water bath without affecting the 2,3-diphosphoglycerate, which is markedly resistant to acid hydrolysis. The resultant mixture of adenine, ribose-5-phosphate and 2,3-diphosphoglycerate was adjusted to *p*H 9·0–9·5 with *N* ammonium hydroxide and passed through a 'Dowex-1-Cl' column. Adenine was eluted with 0·001 *N* hydrochloric acid, and purity was established by spectrophotometry, paper chromatography, and ribose and phosphorus analyses.

Aliquots of the eluates were plated on planchets at infinite thinness and assayed for radioactivity in a 'Nuclear-Chicago' gas flow counter with a micromil window. Rechromatography and elution from 'Dowex-1-Cl' resin and from Whatman No. 1 filter paper resulted in no change in specific activity.

Hæmin was prepared from a small aliquot of washed erythrocytes. Standard samples, recrystallized to constant radioactivity, were assayed.

The results, summarized in Fig. 1, indicate that glycine-2-^{14}C serves as a precursor of the adenine moiety of erythrocyte adenosine triphosphate. They also confirm[3] the stability of the hæmoglobin of the rabbit erythrocyte during the 65–70 day life-span despite the somewhat greater lability of the rabbit erythrocyte compared to that of the human red cell[2]. In contrast to the relative metabolic stability of the hæm, the metabolic behaviour of the adenine portion of the adenosine triphosphate is clearly different since the specific activity of the adenine declined exponentially after about the fifth day and reached a very low activity after about 55 days.

In order to explain the decline in the specific activity of the adenine, several possibilities, which may not be mutually exclusive, should be considered. One possible explanation is that the mature erythrocyte is capable of synthesizing the purine portion of adenosine triphosphate. This would result in a gradual decrease in its specific activity. Thus far, however, in several experiments in this laboratory *de novo* synthesis of adenosine triphosphate adenine from glycine-2-^{14}C has not been demonstrated in the mature erythrocytes of rabbit or man, *in vitro*. Although these preliminary experiments do not eliminate the possibility of a biosynthetic mechanism, they suggest that a complete pathway may be lacking. The possibility of the absence of a purine-synthesizing system in the mature mammalian erythrocyte is compatible with the absence of a number of other common metabolic processes, such as the synthesis of nucleic acid and protein, the Krebs tricarboxylic acid cycle, and the cytochrome system. It is also of interest to note[3] that in rabbit bone marrow, *in vitro*, there is a limited ability for the synthesis of nucleic acid purines from formate-^{14}C. Further studies bearing upon this problem are in progress.

Dilution of the isotope as a result of an exchange with preformed adenosine triphosphate is unlikely

since there is little or no adenosine triphosphate in rabbit plasma and since the mature erythrocyte is considered to be impermeable to phosphorylated compounds. Phosphorylation of adenosine or inosine is unlikely because there appears to be no significant concentration of purine nucleosides in the peripheral blood. Furthermore, adenosine would be expected to undergo deamination by the active adenosine deaminase of the rabbit erythrocyte. Inosine is known to undergo extensive phosphorylytic cleavage in the rabbit erythrocyte.

The alternative explanation for the observations would result from a decreasing level of adenosine triphosphate in the erythrocyte during the *in vivo* ageing process so that the amount initially provided to the cell is gradually depleted. The decline in specific activity would be due to dilution by the adenosine triphosphate of younger cells in which the concentration would be at a higher level. There is some evidence bearing upon this possibility. It is known that the adenosine triphosphate concentration in reticulocytes is about 2·5 times that of mature erythrocytes[9]. The level of adenosine triphosphate in a sample of mature erythrocytes is actually an average concentration of adenosine triphosphate in a cell population of all ages. Our results may be explicable in terms of a progressive diminution in adenosine triphosphate content in each erythrocyte concomitant with ageing of the cell. If such a decline in the content of adenosine triphosphate of the aged erythrocyte occurs, it may result in the impairment of one or more reactions essential for the integrity of the erythrocyte and thus contribute to the demise of the cell. It is known that a decline of adenosine triphosphate in an erythrocyte accompanies *in vitro* ageing and, in fact, is responsible for the lost ability of *in vitro* aged cells to metabolize glucose because of the requirement of adenosine triphosphate for its phosphorylation.

The possibility that the content of adenosine triphosphate of the circulating erythrocyte is a determinant of its life-span is being studied.

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EXAMINATION OF CELLULOSE FIBRE BY THE LOW-TEMPERATURE SPECIMEN METHOD OF ELECTRON DIFFRACTION AND ELECTRON MICROSCOPY

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THE electron diffraction method has the advantage of yielding fairly intense diffraction patterns from a very small amount of material. Recent techniques of electron diffraction have improved this advantage further, making it possible to confine the effective specimen area to a very small size of the order of $1 \times 1\,\mu^2$. By means of a method originated by Hillier[1] we can focus the electron beam on an area of this size in specimens. By means of the three-stage electron microscope originated by Boersch[2] and le Poole[3], we can select the specimen area from the field of the highly magnified electron image. Preston and Ripley[4] applied this method to the study of the cell wall of *Valonia*. They verified the correspondence between the textural and atomic structures of the microfibril, and observed in detail the structure of the wall, which consisted of sheets of differently oriented microfibrils.

Unfortunately, however, the atomic structures of an organic substance like cellulose fibre are so liable to be damaged by irradiation in electron beams that the crystalline diffraction patterns can be observed for only a very short time. Preston and Ripley succeeded in taking photographs of the diffraction patterns from *Valonia* microfibril by reducing greatly the irradiating intensity. They stated in their report that it was also necessary to lower the accelerating voltage of electrons to as low as 25 kV. This condition seems to us rather unfavourable. The damage to atomic structure in the specimens is considered to be caused mainly by the rise in temperature of the specimens due to the electron bombardment; and the lowering of the accelerating voltage must increase the interaction of electrons with the specimens and so increase the rise in temperature. In fact, we observed that the crystalline diffraction patterns of *Valonia* microfibril were maintained for a longer time under irradiation by 100 kV. electrons than by 50 kV. electrons, though even with the higher accelerating voltage it was not easy to maintain the patterns longer than a few seconds under irradiations of usual intensity.

In order to avoid this difficulty we devised a method of cooling the specimens. Concerning cooling devices for specimens in an electron diffraction camera and in an electron microscope, one of us

(G. H.) and other collaborators[5] have previously reported in detail.

Cooling the specimens was, in fact, very effective in protecting them from damage. It was not difficult to observe the crystalline diffraction patterns from *Valonia* microfibril for as long a time as necessary even with fairly intense irradiation, namely, with irradiations giving apparent electron micrographs of direct magnification of 5,000.

Figs. 1 and 2 reproduce two pairs of electron micrographs and diffraction patterns of *Valonia* microfibril taken by Boersch–le Poole's method. Fig. 1 was taken without cooling and Fig. 2 by cooling the specimen to −40° C. The improvement in the diffraction pattern by cooling is evident. This specimen is composed of two sheets of microfibril having fibre axes along the directions indicated by the arrows.

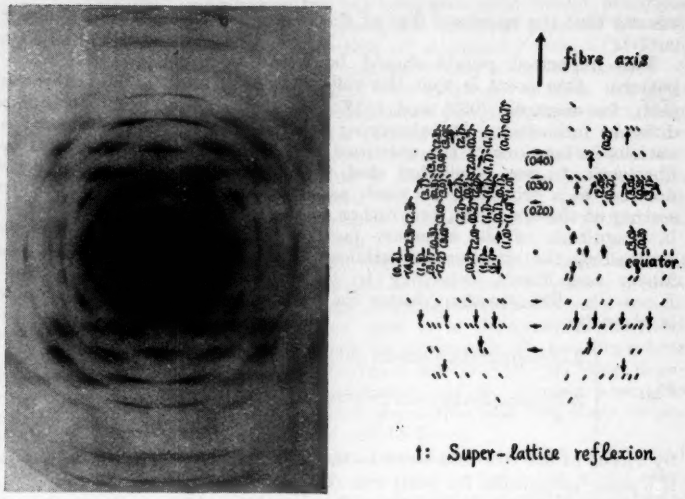

Fig. 3. Electron diffraction pattern of *Valonia* microfibril cooled to − 100° C. taken by Hillier's method

Fig. 3 reproduces the electron diffraction pattern from *Valonia* microfibril cooled to − 100° C. taken by Hillier's method. This specimen was composed of a single sheet of microfibrils. It may be noted that this pattern contains a very large number of reflexions having fairly good resolution up to as high as the tenth layer line. In Fig. 3 as many as 400 reflexion spots appear, while the usual methods give at most a few score reflexions. This improvement in the diffraction pattern is considered to have resulted partly from the reduction of the thermal agitation by cooling and partly from the selection of a good crystalline part in the specimen.

Many of the reflexions in Fig. 3 can be indexed by a monoclinic unit cell having $a = 8{\cdot}39$ A., $b = 10{\cdot}58$ A., $c = 7{\cdot}94$ A., and $\beta = 82°$, which is nearly identical to that proposed for cellulose I by Meyer and Misch[6]. These reflexions are shown by the black circles in Fig. 4, which is the projection of the reciprocal lattice in the (010)-plane. The numerical figures attached to the circles indicate the indices of the layer lines on which the reflexions appeared. It has been reported that cellobiose chains within the microfibrils of *Valonia* have a selective orientation called 'biaxial' or 'uniplanar' orientation, that is, an orientation for which not only the *b*-axis is parallel to the fibre axis but also the (101) lattice plane is parallel to the plane of the wall. The appearance of the observed reflexions can be understood if we

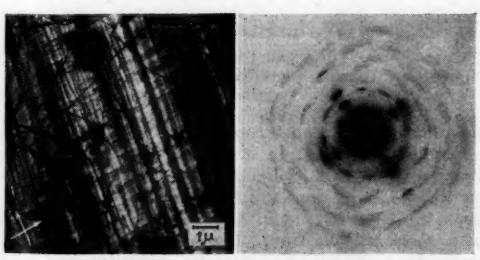

Fig. 1. (*a*) Electron micrograph; and (*b*) electron diffraction pattern of *Valonia* microfibril taken without cooling by Boersch–le Poole's method

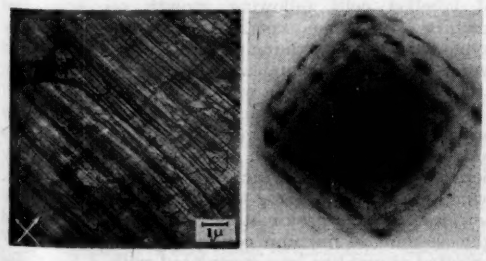

Fig. 2. (*a*) Electron micrograph; and (*b*) electron diffraction pattern of *Valonia* microfibril cooled to − 40° C., taken by Boersch–le Poole's method

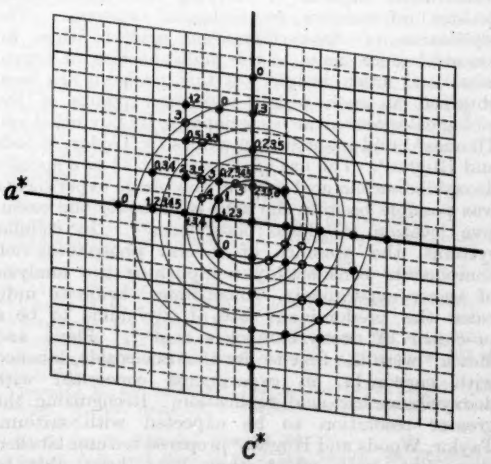

Fig. 4. (010)-Projection of reciprocal lattice. ●, Observed reflexions, which can be indexed by Meyer and Misch's unit cell; ○, super-lattice reflexions

assume that the specimen film of the microfibril was curled.

Two important points should be noted in this pattern. One point is that the reflexions (hkl) and $(\bar{h}k\bar{l})$, for example, (032) and (03$\bar{2}$), have markedly different intensities. By observing the patterns for various inclinations of the specimen film around the fibre axis, it was concluded that the difference is not due to a trivial origin such as an asymmetric setting of the specimen, but rather to the difference in magnitude of the structure factors. This fact contradicts the structure of cellulose I proposed by Meyer and Misch, belonging to the space group $P_{2_1} = C^2_2$. The structure factor for the space group is given by

$$F_{hkl} = \begin{cases} 2\Sigma_j f_j \exp.(2\pi i k y_j) \cos 2\pi (hx_j + lz_j) : k = \text{even} \\ 2i\Sigma_j f_j \exp.(2\pi i k y_j) \sin 2\pi (hx_j + lz_j) : k = \text{odd} \end{cases}$$

by virtue of the two-fold screw axis, and would have the same magnitude for (hkl) and $(\bar{h}k\bar{l})$ reflexions.

Another point to be noted in the pattern is the appearance of the reflexions indicated by the arrows (Fig. 3). They are on layer lines other than the equator. The reciprocal lattice points for these reflexions must lie upon the circles described in Fig. 4. Thus they can be indexed not by the Meyer–Misch unit cell, but by a unit cell having a and c periods twice as long as those of the Meyer–Misch unit cell.

Thus the structure appropriate for the pattern is decidedly different from the structure of cellulose I. Of course, it is different also from other structures proposed for cellulose, such as cellulose II, III and IV. It is certain that the cooling of the specimen did not influence the formation of the structure, since the reflexion characteristic of it was observed also for the specimen without cooling.

We have not yet established the details of the structure. But at least it is certain that the arrangement of cellobiose chains along the fibre axis has an order considerably different from that proposed by Meyer and Misch for cellulose I. We are not yet certain whether this structure is a new one or whether it is the correct structure for cellulose I. However, since the previous determinations of the structure of cellulose were based generally on X-ray diffraction patterns of poor resolution, their renewed examination by the new technique used above seems to be worth while.

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DISTRIBUTION OF TRITIUM-LABELLED THYMIDINE IN *ESCHERICHIA COLI* DURING CELL MULTIPLICATION

By Dr. R. B. PAINTER, F. FORRO, jun., and W. L. HUGHES

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CONSIDERABLE evidence[1] shows that deoxyribonucleic acid is at least one of the chemical constituents capable of carrying and transmitting genetic information in biological systems. The replication of deoxyribonucleic acid is thus an essential prerequisite to the multiplication of organisms, and fresh insight on this problem has been obtained at such widely separated points of the biological spectrum as bacteriophage by Levinthal and Thomas[2,3] and plant chromosomes by Taylor, Woods and Hughes[4]. The use of phosphorus-32 as a specific deoxyribonucleic acid label in the phage experiments was possible because the acid is probably the exclusive location of phage phosphorus[5,6]. In cellular systems, the presence of several phosphorus-rich components considerably complicates the analysis of tracer experiments. Biochemical evidence indicates the predominant fate of thymidine to be a precursor of deoxyribonucleic acid[7–9]. Plaut and Mazia[10] were the first to use this nucleoside, labelled with carbon-14, in experiments concerned with deoxyribonucleic acid replication. Recognizing the greater resolution to be expected with tritium, Taylor, Woods and Hughes[4] prepared tritium-labelled thymidine, with which they have been able to demonstrate a remarkable orderliness for the replication of the deoxyribonucleic acid of individual chromosomes in plant roots. In bacteria, the morphological organization of the acid is far from clear. Using phosphorus-32, some limits have been placed on this organization and the mode of replication of deoxyribonucleic acid in *Micrococcus cryophilus*[11] and in *Escherichia coli* B/r[12]. The availability of tritiated thymidine of suitable specific activity and of a thymine-requiring strain of *E. coli* (*Escherichia coli* 15 T-), the deficiency of which can also be satisfied by thymidine[13], made it seem useful to study the distribution of the incorporated label among the daughters of labelled cells following growth on unlabelled medium. Since the experiments almost immediately indicated a rather striking qualitative result, we felt it worth while to communicate our initial observations.

Escherichia coli 15 T- was kindly supplied by Dr. Hazel Barner. Thymidine, labelled with tritium on the pyrimidine ring, was radiochemically pure as judged by crystallization with carrier (analysis by Schwarz Laboratories, Inc., Mt. Vernon, New York, which are now supplying the material). The specific activity was approximately 2 μc./μgm. Liquid glucose-mineral medium containing 2–4 μgm./ml. of tritiated thymidine was inoculated with a log-phase culture, suitably diluted to minimize carry-over of unlabelled thymidine. Following at least 100-fold growth at 37° C. in the labelled medium, two types of

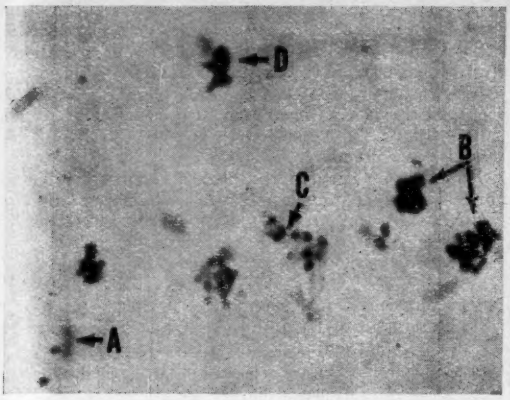

Fig. 1. Autoradiograph (× 1,600) of *E. coli* labelled with tritiated thymidine and grown in non-radioactive medium for about three generations. *A*, an example of cell showing no label; *B*, clusters of grains caused by heavily labelled cells, the grains overlying and obscuring the bacteria; *C*, an example of lightly labelled cells, where eleven individual grains can be observed over three or four cells; *D*, an example of an 'all-or-none' split, where one of a pair of cells has a cluster of grains over it, while the other has none

experiments were performed. In the first, the cells were washed in saline and grown in medium containing excess unlabelled thymidine. Direct cell counts from aliquots were taken at the time of inoculation and every 30 min. thereafter. Each time a doubling of the population of the culture occurred, as determined by the direct cell count, smears were made. These were fixed by heat, washed with water, and autoradiographs made by the stripping film technique[14]. After various exposure times, varying from 5 to 40 days, the slides were developed and stained with 0·04 per cent crystal violet. In the second type of experiment, labelled cells were isolated micromanipulatively on nutrient agar medium which contains excess unlabelled precursor. Progeny lines were obtained from these isolates, cell growth stopped by drying the agar medium, and stripping film autoradiographs made after fixing in 3 : 1 ethyl alcohol–glacial acetic acid and a series of alcohol–water solutions.

Both experiments revealed very clearly that the distribution of the incorporated tritium from the tritiated thymidine among the daughter cells grown on unlabelled medium is very heterogeneous (Fig. 1). At least as soon as the third generation and possibly sooner, one finds cells with no label in the presence of those containing considerable label. In the liquid-culture experiment, all-or-none splits, where one of an unseparated pair of cells exhibited heavy label (6–14 grains) while the other had no grains above it, were observed occasionally. Even allowing for some possible trackiness which appears to be present in the grain patterns, the magnitude and frequency of such splits made it extremely unlikely that they occur by chance. Such all-or-nothing splits are also seen in the micromanipulation experiments where the sibling relations in the progeny line are known. These micromanipulation experiments indicate that the heterogeneity observed in bulk culture experiments is not primarily a result of the death of the cell (from radiation or any other cause) and/or differences in growth-rates for individual bacteria.

Two additional comments can be made: (1) At the first division on cold medium, no case of all-or-nothing distribution has yet been seen even though attempts were made to select the smallest possible labelled cells as the sources of a progeny line. (2) Each clonal line does not show the same distribution of label. Specifically, each starting cell does not give rise to a unique number of hot cells dispersed among other cold ones; rather, the distribution of grains differs from clone to clone. In some, the distribution would be difficult to distinguish from random. In the rest, 'hot spots' and all-or-nothing splits occur at different frequencies and in patterns which still require deciphering.

The question of whether all the label is in bacterial deoxyribonucleic acid has not been completely settled. The best chemical estimates to date indicate that no less than 80 per cent is in deoxyribonucleic acid thymidine. Check experiments with two organisms not requiring thymine for growth, *Bacillus megaterium* and *Escherichia coli* B, showed that the uptake of tritiated thymidine was less than 10 per cent of that of *E. coli* 15 T-.

The observation that simple dilution of tritiated thymidine during growth does not occur would seem to indicate that relatively large amounts of parental deoxyribonucleic acid can remain functionally associated in transmission to daughter cells. It is also clear that the extent of this association of the parental deoxyribonucleic acid differs from clone to clone; that is, there is a reasonable probability of a sharing of at least some of the parental deoxyribonucleic acid between daughters at division. These results are not inconsistent with findings for deoxyribonucleic acid phosphorus-32 distribution in another bacterium[11]. Whether the functional two-strandedness of both phage and plant chromosomal deoxyribonucleic acid will be found to hold for bacteria is not clear from the results, although the lack of all-or-nothing splits at the first generation and their appearance in later generations are not in conflict with this possibility.

An exclusive model to explain these results depends, among other things, on independent information concerning the number of deoxyribonucleic acid-containing structures within a bacterium and on the quantitative aspects of the distributional patterns. We hope to report in more detail on these problems in the future.

We would like to express our thanks to Dr. J. H. Taylor for his interest and helpful discussion during the course of this work. The second author wants to express his sincere appreciation to Miss D. Patricia Frost for her excellent assistance in performing his part in these experiments.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Rate of Accretion of Cosmic Dust on the Earth

As guest professor of geophysics at the University of Hawaii, I have had opportunities for collecting cosmic dust by filtering large volumes of air through fine-pored filters at Mauna Loa Observatory on Hawaii (11,000 ft.) and from the summit of Mt. Haleakala on Maui (10,000 ft.), localities where the air is generally free from terrestrial dust to a remarkable degree. The filters were analysed for the radioactive fall-out products, strontium-89 and strontium-90, in the laboratories of the U.S. Atomic Energy Commission in New York, and for iron, nickel and cobalt in the II Chemisches Institut der Universität, Vienna. I am indebted to Mr. John H. Harley for the strontium analyses, which will be published elsewhere, and also to Prof. F. Hecht and his collaborator Dr. E. Tomic of Vienna for carrying out the analyses for the ferrides.

Of the twenty-two filters from Mt. Haleakala so far analysed for ferrides, all contained notable quantities of nickel, whereas in seven of the nine filters from Mauna Loa nickel was also found, far in excess of any possible contamination from terrestrial sources. The average weight of nickel per 1,000 m.^{3} of air passed through the filters was 14·3 μgm. as compared with 1,577 μgm. of iron, that is, a nickel to iron ratio of 0·9 per cent. Cobalt was also found in several of the filters, although in much smaller quantities than nickel, the ratio of cobalt to iron being 0·2 per cent.

The weight of cosmic dust on the filters may be estimated from the nickel content using the average amount (2·5 per cent) of nickel in meteorites of all kinds quoted by F. G. Watson[1], which gives a weight of meteoric dust of 572 μgm./1,000 m.^{3} of air.

Assuming the dust-content of cosmic origin in the atmosphere to be uniform up to the 100-km. level, for the whole atmosphere below that level a quantity of suspended dust of cosmic origin of 28·6 million tons is obtained.

In order to find from this figure a value for the annual increment of cosmic dust to the Earth, we have to assume a probable rate of descent from the 100-km. level to the 3-km. level, where the dust was collected. In the case of the finest volcanic dust from the Krakatoa eruption in 1883, according to W. J. Humphreys[2], it required about two years to settle down to the Earth's surface. With a similar rate of descent, the cosmic dust suspended in the atmosphere should be renewed in the course of two years, which makes the annual increment of such dust to the Earth equal to one half the figure given above, or 14·3 million metric tons. If more rapid renewal of the cosmic dust suspended in the atmosphere is assumed, the annual increment becomes correspondingly higher.

Comparing this figure with Van de Hulst's value[3] for the weight of the interplanetary dust giving rise to the zodiacal light and being swept up by the Earth, as 1,700 tons a day, one obtains a rate of accretion for interplanetary dust to the Earth of only a little more than 4 per cent of that for meteoric dust, or 0·62 million tons a year.

On the other hand, Watson assumes the total weight of meteoric matter reaching the Earth to be "between 1,000 or, perhaps, 10,000 tons per diem" (ref. 1, p. 94). Even with the higher of these two estimates, one finds that a total weight of 3,650,000 tons of meteoric matter should reach the Earth annually, or about one-fourth of that estimated from these experiments.

Considering the general interest for many different branches of geophysics of the rate of accretion of cosmic dust, these discrepancies call for repeated and extended experiments of this kind at other high-altitude observation posts.

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Oct. 31.

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Energy Spectrum of Cosmic Radiation

The spectrum of cosmic radiation has the remarkable property that it is a power function

$$f = \text{const. } p^{-n} \qquad (1)$$

(where p is momentum), in which n has a constant value of about 2·5 for several powers of ten of p. In Fermi's theory, n is given by the ratio τ/T between the time of acceleration τ and the time of absorption (or diffusion) T. This means that the empirical formula is obtained only if one assumes that accidentally τ and T are of the same order of magnitude, and that the ratio is constant over a very wide range of momentum. Neither of these assumptions is plausible.

It is the purpose of this communication to point out that a power law can be obtained if we assume that particles, which are injected at low energies, are pumped up to higher energies by a pump, the speed of which is a power function of the momentum. No considerable loss of particles should occur during the acceleration, but when the particles have reached the maximum energy which can be stored in the accelerator, they leave the accelerator. (In this way the time of dissipation is determined by the time of acceleration.) Hence all cosmic-ray particles move up through the energy spectrum in a more or less systematic way, and the time they spend in a certain energy-range is inversely proportional to the speed of the pump.

This effect can be produced in several ways, and we shall consider a mechanism in which the betatron effect is combined with a scattering or diffusion of the particles[1]. If the magnetic field H in a certain volume U' increases, the momentum p of charged particles in the volume increases by Δp, which is proportional to p. If the particles are scattered, or diffused out of U' to an adjacent volume where H is constant, and later the field in U' returns to its initial value, the net result of the process is that a number of particles fU' have increased their momenta by

$$\Delta p = \alpha p \qquad (2)$$

where α is a constant. If the process is iterated and low-energy particles are injected at a constant rate, this leads to a power spectrum with $n = 1$.

If this process takes place in the neighbourhood of the Sun under influence of varying magnetic fields

produced by solar activity (cf. ref. 1), the value of n may be changed for geometrical reasons. Particles that have gained enough energy diffuse away from the environment of the Sun and fill a volume U which we may put equal to :

$$U = \beta p^b \qquad (3)$$

where β is a constant and $b = 2$ or 3 depending on the properties of the trapping field. They may be accelerated further, but at a slower rate because the average value of α decreases when the distance from the Sun increases. Hence α depends implicitly on U, and we may put :

$$\alpha = a.U^{-\nu} \qquad (4)$$

A stationary state requires that the number of particles dn passing a certain momentum p is independent of p. Thus we have :

$$Uf\Delta p = \text{const.}$$

or from (2), (3) and (4) :

$$f = \text{const. } p^{-n}$$

with $n = b(1 - \nu) + 1$. An agreement with the observational value $n = 2{\cdot}5$ requires $\nu = 0{\cdot}25$ for $b = 2$, or $\nu = 0{\cdot}5$ for $b = 3$.

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Confinement of Charged Particles by a Magnetic Field

Diffusion which is caused by collisions in an ionized gas and which takes place across a magnetic field is known to be reduced by the field. The gas may be confined to a limited region, provided that particles can escape neither by motion along the field nor by drift motion across it. In the longitudinal direction, the particles may be trapped by strong field inhomogeneities[1] or simply by having the field lines closed within the gas volume.

Axially symmetrical, stationary magnetic fields **B** and electric fields **E** will be discussed in the present communication. The radius of gyration of a particle is assumed to be small and the drift velocity $\mathbf{u} = \mathbf{u}_\parallel + \mathbf{u}_\perp$ to be determined by[2] :

$$\mathbf{u}_\perp = \left(q\mathbf{E} - \mu\nabla B - m\frac{d\mathbf{u}}{dt}\right) \times \mathbf{B}/(qB^2) \qquad (1)$$

where ($\parallel$) and ($\perp$) denote directions parallel with and perpendicular to **B**, q the charge, m the mass, μ the magnetic moment of the equivalent dipole representing the gyrating particle and $d/dt = \partial/\partial t + (\mathbf{u}.\nabla)$. We write :

$$(\mathbf{u}\cdot\nabla)\mathbf{u} = (\mathbf{u}_\parallel\cdot\nabla)\mathbf{u}_\parallel + (\mathbf{u}_\parallel\cdot\nabla)\mathbf{u}_\perp + (\mathbf{u}_\perp\cdot\nabla)\mathbf{u}_\parallel + (\mathbf{u}_\perp\cdot\nabla)\mathbf{u}_\perp \qquad (2)$$

A magnetic field produced by a toroidal coil forms circles around the axis of symmetry, that is, the z-axis in a co-ordinate system (r, φ, z). Particles cannot be trapped in the field which gives rise to a drift motion in the z-direction.

Instead, a poloidal field is considered as shown in Fig. 1, where both **B** and **E** are supposed to be

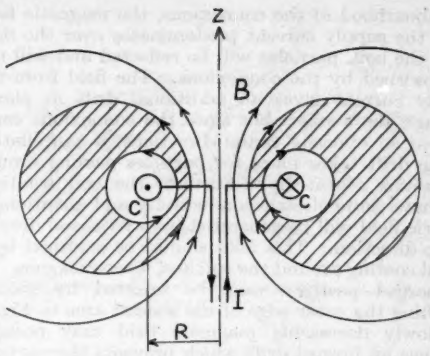

Fig. 1. The magnetic field **B** generated by a circular coil C

situated in planes through the z-axis. **E** may arise partly from ambipolar diffusion. The first and the fourth terms in the right-hand member of equation 2 give centrifugal forces in planes through the z-axis, whereas the third term as well as the second term give a contribution $\mathbf{u}'_\perp$ to the total drift velocity $\mathbf{u}_\perp$. The velocity $\mathbf{u}'_\perp$ is situated in planes through the z-axis, whereas all other contributions, $\mathbf{u}_\perp - \mathbf{u}'_\perp$, are drift motions in circles around the same axis. The motion $\mathbf{u}'_\perp$ of ions differs from that of electrons, and this may cause a separation of charge and generate an electric field. However, the drift arising from this additional field will be situated in the φ-direction, provided that the density distribution of the particles is axially symmetrical. The relative importance of $\mathbf{u}'_\perp$ is roughly estimated from equations 1 and 2 :

$$\mathbf{u}'_\perp/\mathbf{u}_\perp \approx mu_\parallel/qBR \qquad (3)$$

If the gas approaches thermodynamic equilibrium, the velocity of gyration becomes comparable to $u_\parallel$, and $u'_\perp/u_\perp$ is nearly equal to the ratio between the radius of gyration and the characteristic distance R. As an example, we may choose an ionized deuterium gas at $T = 10^8$ °K. in a magnetic field $B = 30$ V.sec./m.^{2} (3×10^5 gauss) produced by a coil of radius $R = 5$ m. For ions, $u'_\perp/u_\perp$ becomes about 10^{-4} and for electrons about 10^{-6}. Even if the electric field should be as high as $V/R \approx 3 \times 10^3$ V./m., where V is the potential drop corresponding to the particle energy $3kT/2$, the drift $u'_\perp$ is not greater than 4×10^{-2} m./sec. for ions and 6×10^{-4} m./sec. for electrons. Ions will escape after about 50 sec. if only the drift $\mathbf{u}'_\perp$ is taken into account and particle interactions are neglected. Thus, a strong magnetic field is able to trap particles effectively inside a region such as that shaded in Fig. 1, at least at low gas densities.

Time variations of the magnetic field induce an electric field E_φ and a drift $\mathbf{u}''_\perp$ in planes through the z-axis, directed outwards from the coil windings when $\partial B/\partial t$ is positive. It has the magnitude :

$$|\mathbf{u}''_\perp| \approx (R/B)\cdot\left|\frac{\partial B}{\partial t}\right| \qquad (4)$$

and may be regarded as a motion of matter 'frozen to' the magnetic-field lines. If B is changed by the amount ΔB during the time Δt, the displacement by the drift $\mathbf{u}''_\perp$ becomes about $R\Delta B/B$.

The magnetic field may be produced by a coil C as in Fig. 1, where the areas of the coil connexions are made as small as possible. If, in the immediate

neighbourhood of the connexions, the magnetic field from the supply current predominates over the field from the coil, particles will be reflected and will not be absorbed by the connexions. The field from the supply current gives an additional drift in planes through the z-axis; but since the connexions carry current in opposite radial directions, a cancellation of the drift takes place for particles passing around the z-axis repeatedly. Further, the coil windings will have finite electric conductivity and a stationary electric field will be generated by a potential drop in the φ-direction. This field should be screened by a metal coating around the coil and its connexions.

Charged particles may be injected by sources touching the outer edge of the shaded area in Fig. 1. A slowly decreasing magnetic field may possibly produce an inward drift which prevents the particles from hitting the sources repeatedly.

Confinement at high gas densities is outside the scope of this short communication and requires more knowledge about the stability of the field, the pressure balance and the interactions between particles. The coil windings may act as a metallic wall and have some stabilizing effect on deformations of the magnetic field by motion of the gas. A particle density $n = 6 \times 10^{22}$ m.$^{-3}$, corresponding to a pressure $P \approx B^2/4\mu_0$, gives a reaction time of 15 sec. in the example above. The behaviour of a toroidal induced discharge[3] is of great interest in the present connexion.

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A Travelling-Wave Parametric Amplifier

The principle of parametric excitation of an oscillatory system has been known for many years. An electric oscillatory circuit can be excited in this way if the condenser plates are instantaneously pulled apart by a fixed amount whenever the voltage reaches a maximum value, and instantaneously restored to their original positions when the voltage is zero. Under these conditions energy is communicated to the circuit when the plates are pulled apart; but none is extracted when they are restored, and so oscillations can be maintained. The capacitance/time graph envisaged in the foregoing is a square wave at twice the resonant frequency of the circuit; but it can be shown that a sinusoidal variation at twice the resonant frequency may be used. Any method of periodically varying the capacitance may be used, or alternatively the inductance may be varied. Moreover, such a circuit can be used as an amplifier, since, at the fundamental frequency, the excitation mechanism is analogous to negative resistance.

In considering the possibility of obtaining a useful amount of parametric amplification at high radio-frequencies, a travelling-wave type of parametric excitation has been studied. It has been found that a loss-less transmission line having distributed inductance per unit length given by:

$$L = L_0[1 + \eta \sin 2(\omega t - \beta x)]$$

and constant distributed capacitance C_0 per unit length will support a growing current wave of the form

$$i = i_0 \exp(\alpha x) \sin(\omega t - \beta x + \varphi)$$

where

$$\alpha \doteqdot \omega\sqrt{L_0 C_0}\,\frac{\eta}{4}\cos 2\varphi$$

$$\beta \doteqdot \omega\sqrt{L_0 C_0}\left(1 - \frac{\eta}{4}\sin 2\varphi\right)$$

If $\cos 2\varphi = 1$ the maximum possible amplification is obtained and $\alpha = \omega\sqrt{L_0 C_0}\,\frac{\eta}{4}$ nepers per unit length. Under these conditions it is also found that $\beta = \omega\sqrt{L_0 C_0}$.

For example, if $\eta = 0{\cdot}1$, a gain of 1·36 db./wavelength is theoretically obtainable. However, this amplification is only obtained when the frequency ratio is precisely 2, and the correct phase relationship must be preserved if the maximum amplification is desired. Thus, the oscillator used for providing the periodic variation of inductance must be synchronized to the incoming signal.

The noise figure of such an amplifier should be very favourable, and an experimental study is being made. Related schemes, in which precise frequency and phase relationships are not demanded, are also being studied.

I am greatly indebted to Mr. I. M. Ross of the Services Electronics Research Laboratory, Harlow, for a stimulating conversation about parametric amplification.

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Lattice Image of Twin Structure observed directly by Electron Microscope in a Crystal of Copper Phthalocyanine

Recently, with the increase of the resolving power of the electron microscope, it has become possible to make a direct observation of a crystal lattice composed of large molecules. J. W. Menter[1] succeeded for the first time in observing the lattice structure and the edge dislocation contained in it in crystals of metal phthalocyanines. This method is also applicable to the study of the local variation of the fine structure in a crystal lattice, and the so-called selected area micro-diffraction method, when used jointly with this method, has proved its further usefulness.

As an example of such an application, we have observed directly the twin structure in the crystal lattice of the stable copper phthalocyanine, which has a lath-shaped crystal habit. It is well known that this substance has a crystal structure with space group $P\,2_1/a$ of the monoclinic system, as reported by Robertson[2], and a crystal habit in which generally the (001) plane is the largest habit surface; the crystal lath usually lies on this surface, and the b-axis coincides with the direction of the longest edge of the lath-shaped crystal. The lattice image of the (20$\bar{1}$) plane was observed by Menter with the crystal of such habit. Further investigation has shown that some crystals of the stable copper phthalocyanine frequently acquire another lath-shaped crystal habit in

which the lattice plane (001) runs almost perpendicular to the flaky habit surface, which may correspond to such a plane as (20$\bar{1}$), contrary to the ordinary crystal habit. We have also taken electron micrographs of the lattice image corresponding to the (001) plane as reported in the previous paper[3]. The periodic spacing of the lattice image of the (20$\bar{1}$) plane is about 9·8 A., even when the effect of the slight inclination of the lattice plane to the surface of the usual habit is taken into consideration, while that of the (001) plane is estimated to be about 12·6 A. and is obviously larger than the spacing of the (20$\bar{1}$) plane in the ordinary crystal habit.

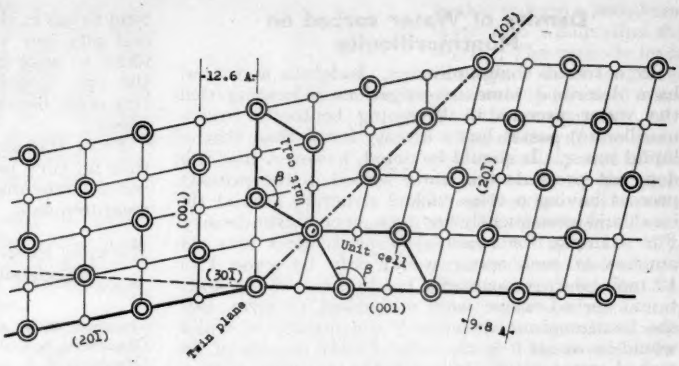

Fig. 2. Molecular configuration of the twin structure of copper phthalocyanine, projected on the *b*-plane. Small circles are at the level of $\pm \frac{1}{4} b_0$

As shown in Fig. 1, which was taken with a Hitachi electron microscope type *HU*–10, it is often observed that the lattice images of these two crystal habits are parallel and side by side, separated only with a narrow gap. The specimen used here was a stable copper phthalocyanine prepared by boiling the powder of the metastable compound with carbon tetrachloride for about 10 hr.; and it had been completely converted into the stable form. The electron micro-diffraction pattern of the selected area has two series of equidistant diffraction spots that are attributable to (20$\bar{1}$) and (001) reflexions with their higher-order reflexions superimposed on the equator, which is taken in the direction perpendicular to the *b*-axis.

We believe that such a fine structure containing the two different kinds of lattice images is due to the twin structure and is not caused by a fortuitous contact of two kinds of completely separate crystals, because the gap between the two lattices is always very narrow and has almost the same magnitude as the lattice spacing itself. Further, no contour fringe can be observed at the boundary of the two parts, even when the photograph was taken slightly out of focus so that another part of the perimeter would be bounded by the contour fringes.

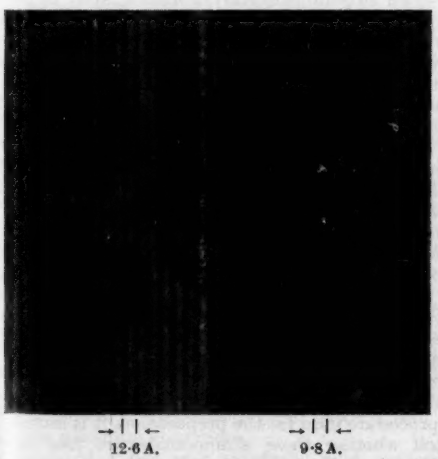

Fig. 1. Lattice image of lath-shaped copper phthalocyanine containing a twin structure

The relation between these two kinds of crystal habits and the twin structure must be considered from the point of view of the molecular arrangement. As the direction of the *b*-axis is common to the separate two parts, and the boundary is also parallel to the same axis, it is reasonable to consider that the twin plane is one of the (*h*0*l*) planes which is also parallel to the same axis. Taking the two kinds of crystal habit into consideration, the most appropriate twin plane, by which the largest habit surface of each part can be brought into a position nearly parallel to the supporting film for electron microscopy, is the (10$\bar{1}$) plane as shown in Fig. 2, in which the two kinds of the largest crystal habit surface, shown by the thick line, cross at an angle of about 14°. With this structure, the crystal can orient itself so that the incident electron beam can simultaneously satisfy the Bragg condition for both the (20$\bar{1}$) and the (001) planes, which contain an angle of about 14°; furthermore, slight relaxation of the bent crystal on the film and the elongation of the intensity region for reflexion accompanying the reciprocal lattice points (caused by the thinness of the lath crystal itself), give the reflexions from the two parts at the same time, thus enabling the lattice image of the twin structure to be observed by the electron microscope. As shown by the broken line in Fig. 2, if the (30$\bar{1}$) plane, in place of the (20$\bar{1}$) plane, is taken as the largest crystal habit surface for the part where the (001) plane runs perpendicularly to the habit surface, the flaky surface of the crystal lath becomes approximately flat as a whole. But the possibility of such structure is considered to be rather small, because the molecular density in the lattice plane of the outer crystal habit surface becomes extraordinarily small compared with the former structure.

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Density of Water sorbed on Montmorillonite

In a recent communication, Anderson and Low[1] have described some investigations indicating that the water present in Wyoming bentonite (montmorillonite) pastes has a density lower than that of liquid water. It should be noted, however, that this does not preclude the water sorbed in the primary process having a close-packed structure around the ions[2], and consequently having a much higher density. For example, for monovalent or divalent ions the amount of such water would only be some 4 or 12 molecules, respectively, per ion, and if the additional sorbed water were considered to have, say, the hexagonal-net structure[3], the density of which would be about 0·9, the value for the density of the sorbed water would drop rapidly at water contents above about 7–10 per cent, and for pastes with 60 per cent water[1] could easily be less than unity. Such a decrease in density of sorbed water is well shown by the results of De Wit and Arens[4], who obtained values as high as 1·41 at 11·6 per cent moisture, dropping to 0·997 above 30 per cent. Somewhat similar results were obtained in this Institute some time ago using a density-bottle technique with a specially devised de-airing procedure and 'Dekalin' as the non-sorbed liquid. Values ranging from about 1·38 at 9 per cent water to about 1·06 at 20 per cent water were obtained—in substantial agreement with the results of De Wit and Arens[4].

The validity of any results for the density of sorbed water are, however, extremely difficult to assess, since every value must necessarily involve the volume of the sorbed water, and this has to be estimated on the assumption that the amount of swelling of the mineral represents the volume of this water. Irrespective of water content, this can only be true if the surfaces of the individual mineral layers are impermeable. It is well known, however, that the layer surfaces of montmorillonite are not continuous but consist of a hexagonal network of oxygen ions with holes of approximate radius 1·3 A. On complete removal of water, ions can, at least partially, fit into these holes. Furthermore, recent unpublished work with montmorillonite saturated with various cations suggests that the oxygen ions of UO_2^{2+} may, to some extent, fit into the holes when the mineral is in the collapsed condition (cf. the results of Nuss and Wey[5]). It is reasonable, therefore, to suppose that at least some water molecules may find their way into such holes, and thus have an apparent density approaching infinity. This factor would influence results whether clay pastes or clay powders are used, and all results must be influenced thereby. It is not possible at present to determine the magnitude of error likely to arise from this cause, or even to decide whether it is appreciable. The fact that montmorillonite equilibrated at 0 per cent relative humidity has, according to De Wit and Arens[4], a higher density than clay oven-dried to 0·0 per cent moisture, cannot be used as an estimate of the size of the effect, since (although no details are given) it is likely that the oven-drying was carried out at 105° C. when a few per cent of sorbed water was still present. In the results obtained at this Institute drying at 190° C. was employed.

Another factor only operative at low water contents is the assumption that the layers are sufficiently flexible to fit closely around the interlayer water 'islands'. Any departure from this condition would tend to act in the opposite way from the above effect and give low values. The magnitude of the error likely to arise from this factor is also unknown, but the two opposing tendencies cannot balance since this error becomes less the higher the proportion of water.

From the above considerations, it would appear that no very useful conclusions regarding interlayer water configuration can yet be drawn from density measurements.

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Amino-acids in Anthracite

A topic of current interest in palæo-biochemistry is the demonstration of chemical constituents in fossils from the earliest plant and animal life. It has been shown that bones of great archæological age may contain appreciable amounts of organic nitrogen[1,2]. Even such highly organized compounds as amino-acids have been identified in fossil shells and bones[3].

As a contribution to these investigations, it seemed worth while to analyse the protein remains in anthracite—one of the oldest fossils known.

The central part of a thoroughly rinsed piece of anthracite from a British mine was ground into a powder in a mortar. After drying, 100-mgm. aliquots of the powder were hydrolysed in ampoules with 6 *N* hydrochloric acid for 24 hr. at 100° C. The hydrochloric acid was afterwards removed by means of freeze-drying. The residue was dissolved in distilled water, filtered to remove coal particles and evaporated *in vacuo* to dryness. The residue was redissolved in 0·2 ml. of distilled water. 100 µl. of the solution were applied to paper sheets (Whatman No. 4) for two-dimensional chromatography in phenol and colloidin–water systems according to Dent[4]. The amino-acid spots revealed with ninhydrin were allowed to develop for 24 hr. in the dark and preserved by treatment with a solution of cupric nitrate in ethanol. The semi-quantitative estimations of the amino-acid content of the spots were made according to Dent[4]. The α-amino-nitrogen content was determined by a method suggested by Woiwod[5].

After two-dimensional paper chromatography, aspartic acid, glutamic acid and glycine could be demonstrated in the coal samples. The semi-quantitative estimation showed a relative proportion of 12 per cent aspartic acid, 40 per cent glutamic acid and 48 per cent glycine. The α-amino-nitrogen content was 0·12 per cent, which roughly corresponds to 1 per cent of amino-acids in the original anthracite sample.

Amino-acids have thus been demonstrated in fossils about 250 million years old. Because of the procedure used for the preparation, it is impossible to tell whether these amino-acids are free or the result of the hydrolysis of peptides, though it is highly probable that the source of the amino-acids was the

original proteins. We cannot, however, give any satisfactory explanation as to why only these three amino-acids, namely, aspartic acid, glutamic acid and glycine, were left unchanged by time, but it is interesting in this connexion to note that Ezra and Cook[6] recently reported the finding of these three amino-acids in fossil bones some thousand years old. Abelson[3] demonstrated the same three amino-acids, together with alanine, leucine and valine, in a fossil of Devonian age.

It is furthermore tempting to correlate our results with those of Chen and Rickenbacher[7], who found traces of aspartic acid and glutamic acid in amphibian eggs. Not until in the gastrula and blastula stages did the rest of the amino-acids appear.

These investigations thus suggest that aspartic acid, glutamic acid and glycine are among the first amino-acids to be formed and the last to be decomposed in living organisms.

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Small-Scale Preparation of Glyoxylic Acid labelled with Carbon-14

During the course of a study of glyoxylic acid metabolism in wheat it became desirable to obtain glyoxylate labelled with carbon-14, a compound which does not appear to be available commercially. Oxalic acid, which is available commercially as oxalic acid-^{14}C, has been used in the synthesis of glyoxylic acid[1–4]. Weinhouse and Friedmann[5] synthesized glyoxylate-^{14}C from oxalate-^{14}C by reduction with mercuric chloride and Grignard magnesium. In order to isolate the crystalline bisulphite addition product of glyoxylate it was necessary to dilute the oxalate-^{14}C (2·25 mgm.) with 900 mgm. of inactive oxalate. Tafel and co-workers[3,4] introduced an electrolytic method for the reduction of oxalate to glyoxylate. These workers used relatively large amounts of oxalate (10 gm.) and obtained very high yields (87 per cent). The reaction was carried out in 10 per cent sulphuric acid at 10° C. with a current of 4 amp. and was complete in 30 min. Mohrschulz[3] investigated the reaction more thoroughly and showed that it could be carried out in 2 per cent sulphuric acid at a temperature of 15–20° C. The highest yields were obtained using mercury as the cathode (rather than lead, copper or nickel).

We have found it possible to extend the electrolytic method to the reduction of milligram quantities of oxalate and have obtained high yields of glyoxylate. The electrolysis apparatus (Fig. 1) consists of a vessel 1·4 cm. in diameter and 2·4 cm. high containing 1 ml. of mercury, a 4½-volt dry-cell battery, and two 26-gauge platinum electrodes.

0·1 ml. of 2 per cent sulphuric acid containing 0·14–3 mgm. of oxalic acid is pipetted into the beaker to form a peripheral layer into which dips the anode. The cathode leads through a short length of glass tubing (diam. 5 mm.) into the mercury.

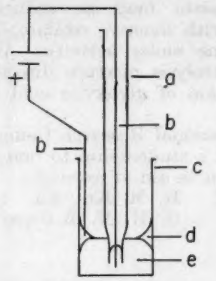

Fig. 1. Electrolysis apparatus used in the reduction of oxalic acid: *a*, glass tube; *b*, 26-gauge platinum electrode; *c*, glass beaker, diameter 1·4 cm.; *d*, reaction mixture; *e*, mercury cathode. Power source is a 4½-V. dry cell

The effects of the quantity of oxalate and of the reaction time on the yield of glyoxylic acid were studied. Some results are shown in Table 1. Glyoxylic acid was determined quantitatively as its 2,4-dinitrophenylhydrazone. The reaction products were treated with a slight excess of 2,4-dinitrophenylhydrazine in 2 *N* hydrochloric acid and the mixture extracted into ethyl acetate. The ethyl acetate extract was washed with ethyl acetate, made to volume and its density determined spectrophotometrically at 368 mμ using a Beckman model *DU* spectrophotometer.

Glyoxylic acid 2,4-dinitrophenylhydrazone was identified by paper chromatography[6]. This compound gives two spots on chromatograms which are recognizable by their R_F values and by their characteristic colour reaction with ethanolic sodium hydroxide.

With 0·7 mgm. of oxalic acid a reaction time of 10 min. was found to be very satisfactory. After a number of trials with inactive oxalate which gave consistently high yields (about 95 per cent), radioactive oxalate was used. 0·7 mgm. oxalic acid-^{14}C (26·5 μc./mgm.) in 0·1 ml. of 2 per cent sulphuric acid was electrolysed for 10 min. and the reaction solution was chromatographed in one direction on Whatman No. 1 paper by the ascending method, using chloroform/95 per cent ethanol, 1/1 + 2 per cent (v/v) formic acid[7] as solvent. In this solvent system the R_F values of oxalic and of glyoxylic acids are 0·06 and 0·80 respectively. Counting the radioactivity directly on the paper showed approximately 95 per cent of the activity in glyoxylate, 3 per cent in oxalate and 2 per cent in an unidentified band of R_F 0·9. The identity of the zone corresponding to glyoxylate was verified by elution of the band with water, and reaction of the eluate with 2,4-dinitrophenylhydrazine followed by paper chromatography. In addition, the 2,4-dinitrophenylhydrazone was hydrogenated, and the resulting radioactive glycine identified with two-directional paper chromatography[8].

The advantages of this method for preparing glyoxylic acid-^{14}C are that it is simple, rapid and inexpensive. Because it is suitable for use with small

Table 1. Yield of Glyoxylic Acid by Electrolytic Reduction of Oxalic Acid in 2 per cent Sulphuric Acid at 4½ Volts (Mercury Cathode, Platinum Anode)

Time (min.)	Amount of oxalic acid (mgm.)	Yield of glyoxylic acid* (per cent)
15	5·7	22
15	2·9	61
15	1·4	73
15	0·14	59
10	0·7	95
15	0·7	73
23	0·7	71

* Determined spectrophotometrically as 2,4-dinitrophenylhydrazone in 1 per cent sodium carbonate at 368 mμ.

quantities, radioactive oxalate may be reduced directly, without dilution with inactive oxalate, to give glyoxylate of the same molar activity. We have used the diluted electrolysis mixture directly in studies of the dissimilation of glyoxylic acid in plant tissues.

We wish to thank the National Research Council of Canada for the award of a studentship to one of us (R. M. K.) and for a grant in aid of research.

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Distribution of Carbon-14 in Labelled Amino-acids separated on Paper Chromatograms

An important problem in the biochemical application of the labelled pool technique is the determination of the uniformity of labelling of compounds separated on paper chromatograms in amounts below the limits of chemical detection[1].

The use of ninhydrin (triketohydrindene hydrate) as a spray[2] or, preferably, as an acetone dip[3] for the detection of α-amino-acids separated on paper chromatograms, is well established. The reaction involves a quantitative oxidative deamination of the α-amino-acid according to the equation[4–6]:

$$R.CH(NH_2).COOH + O = R.CHO + NH_3 + CO_2$$

The loss of radioactivity from an α-amino-acid separated on a paper chromatogram, as a result of treating it with ninhydrin, might then be expected to indicate the proportion of carbon-14 in the carboxyl group of the acid. This was found not to be the case in practice because of the volatility of the labelled aldehyde also produced, and because decarboxylation only appeared to be quantitative under the right conditions of time, temperature and relative humidity. The effect of relative humidity on the ninhydrin colour reaction has been noted by other authors[7].

The simple method described below was developed for application to α-amino-acids labelled with carbon-14 separated on paper chromatograms and has given reproducible results with known labelled acids as shown in Table 1.

The low recoveries of carbon-14 dioxide from the 1-^{14}C-glutamate are not understood but do not appear to be explained by the presence of carbon-14 in groups other than the 1-carboxyl (see below). The proportions of carbon-14 in the 1-carboxyl group of the labelled amino-acids was confirmed by measuring the specific activity of the $^{14}CO_2$ liberated from carrier-diluted samples on the semi-micro scale by an adaptation of the Van Slyke method[4,5]. These results are shown in Table 2. Doubts earlier expressed[8] on the uniformity of labelling of amino-acids from

Table 1. Ninhydrin Decarboxylation of Amino-acids labelled with Carbon-14 on Paper

Acid	Theoretical proportion of total carbon-14 in carboxyl group (per cent)	Proportion of total carbon-14 recovered (per cent)
DL-Glutamic acid-1-carbon-14	100·0	82·0
,, ,, ,,	100·0	81·0
*Uniformly labelled L-glutamic acid	20·0	20·5
,, ,, ,, ,,	20·0	19·0
,, ,, ,, ,,	20·0	22·7
,, ,, ,, ,,	20·0	21·0
,, ,, L-*iso*leucine	16·6	15·5
,, ,, ,,	16·6	15·5
,, ,, L-phenylalanine	11·1	10·5
,, ,, ,,	11·1	10·1
,, ,, L-valine	20·0	20·8
,, ,, ,,	20·0	19·7
,, ,, L-tyrosine	11·1	11·7
,, ,, ,,	11·1	11·1

* Uniformly labelled acids prepared from *Chlorella* grown in $^{14}CO_2$ as sole carbon source.

Chlorella grown on $^{14}CO_2$ as sole carbon source are now believed to be unfounded (Catch, J. R., personal communication).

The apparatus consists of a 15 cm. × 1·5 cm. 'Pyrex' tube provided with a *B* 14 standard head and vacuum tap as illustrated (Fig. 1). Aqueous sodium hydroxide (40 μl. of 1 *N* solution) is micro-pipetted on to a 2-cm. circle of Whatman No. 1 paper, dried in a warm air stream, and gently pushed into position *A* of the tube. A plug of glass wool washed with hydrochloric acid is inserted at *B* followed by a 1-cm. layer of granular activated charcoal at *C*. Four or five drops of distilled water are placed on the charcoal. A 2-cm. circular sample of the labelled amino-acid zone (located by scanning[1]) is removed from the Whatman No. 1 paper chromatogram by means of a suitable cork-borer. It is weighed and assayed for activity of carbon-14 under a thin end-window Geiger–Müller tube by mounting under rigid and reproducible geometrical conditions and taking the mean of pairs of counts made over both faces of the sample. The sample should not contain more than 50 μgm. of the amino-acid. The sample is briefly dipped in a 0·5 per cent (w/v) solution of ninhydrin in acetone (analytical reagent), quickly dried, and pushed into position *D* of the tube. The *B* 14 head is immediately placed in position, the tube pumped out to approximately 30 cm. of mercury pressure, and the tube warmed in an oven at 90–95° C. for 2 hr. The tube is next allowed to cool for a further hour at room temperature. The alkaline paper circle is then

Table 2. Ninhydrin Decarboxylation of Amino-acids labelled with Carbon-14 in Solution

Acid	Theoretical proportion of total carbon-14 in carboxyl group (per cent)	Proportion of total carbon-14 recovered (per cent)
DL-Glutamic acid-1-carbon-14	100·0	101
,, ,, ,,	100·0	98
,, ,, ,,	100·0	95
*Uniformly labelled L-glutamic acid	20·0	20·2
,, ,, ,, ,,	20·0	21·8
,, ,, ,, ,,	20·0	20·2
,, ,, ,, ,,	20·0	21·6
,, ,, ,, ,,	20·0	20·0
,, ,, L-tyrosine	11·1	11·8
,, ,, ,,	11·1	11·3
,, ,, L-phenylalanine	11·1	10·95
,, ,, L-valine	20·0	18·9
,, ,, ,,	20·0	20·1
,, ,, L-*iso*leucine	16·67	16·4

* Uniformly labelled acids prepared from *Chlorella* grown in $^{14}CO_2$ as sole carbon source.

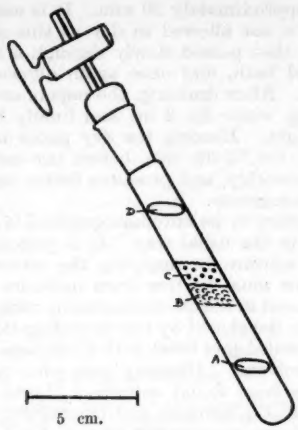

Fig. 1

removed, weighed, and assayed for activity of carbon-14 as above. Self-absorption corrections are made if the weights per unit area of the circles differ significantly[9]. The water in the tube provides the necessary moisture for the reaction, and the activated charcoal selectively absorbs any labelled volatile aldehyde formed. The proportion of the original activity of carbon-14 recovered on the alkaline circle represents the proportion of the carbon-14 present in the 1-carboxyl group. The method provides a simple test for the uniformity of labelling of α-amino-acids.

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Absorption Spectra of Molecular Complexes

It has been shown by several workers[1-4] that there is a rough correlation between the lowest ionization potential of an electron donor and the frequency of the maximum of the charge-transfer band (ν_{CT}) of lowest energy characteristic of the complex of the donor with a given acceptor. That the relation is not a very strict one is illustrated by Fig. 1, where such a plot is given for chloranil complexes in solution in carbon tetrachloride. The ionization potentials are those measured by Watanabe[5] using a photo-ionization method.

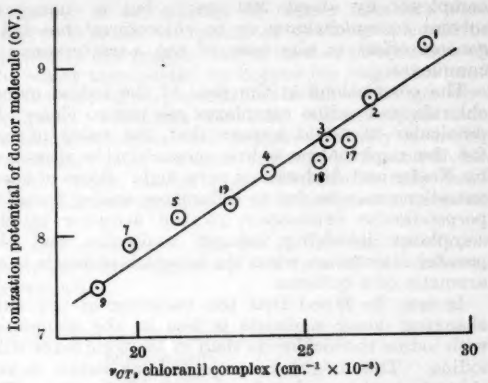

Fig. 1. The relation between the ionization potential of the donor molecule and ν_{CT} of the corresponding chloranil complexes in carbon tetrachloride

However, the plot of ν_{CT} for a series of complexes of electron donors with a particular acceptor against ν_{CT} for the same series of donors with a second acceptor shows a much closer correlation. Examples of such plots are given in Fig. 2. The values of ν_{CT} for the iodine and iodine monochloride complexes are those obtained by Keefer and Andrews[2] and de Maine[6]. It was not possible to assign a reliable value to ν_{CT} for the chloranil–durene complex because of the skew nature of the absorption band. The solvent in all cases was carbon tetrachloride. To change the solvent to *cyclo*hexane increases ν_{CT} for the chloranil

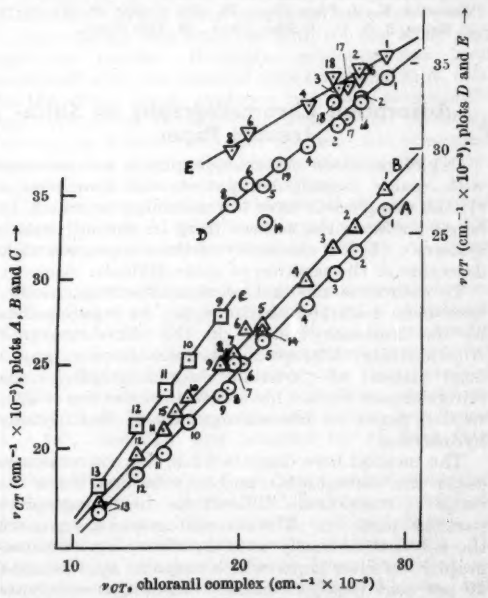

Fig. 2. The relation between ν_{CT} of chloranil complexes and ν_{CT} of complexes involving (*A*) *p*-benzoquinone; (*B*) *s*-trinitrobenzene; (*C*) *s*-trinitrotoluene; (*D*) iodine; (*E*) iodine monochloride. The numbers in the figures refer to the donor molecules: (1) benzene; (2) toluene; (3) *m*-xylene; (4) mesitylene; (5) naphthalene; (6) pentamethylbenzene; (7) 1-methylnaphthalene; (8) hexamethylbenzene; (9) aniline; (10) *N*-methylaniline; (11) *N* : *N*-dimethylaniline; (12) tetrabase; (13) *N* : *N* : *N*′ : *N*′-tetramethyl-*p*-phenylenediamine; (14) phenanthrene; (15) anthracene; (16) dibenzyl; (17) *o*-xylene; (18) *p*-xylene; (19) a:iso e

complexes by about 300 cm.$^{-1}$, but a change of solvent to *cyclo*hexane or to chloroform[4] has little general effect in the case of the *s*-trinitrobenzene complexes.

The correlations in the case of the iodine monochloride and iodine complexes are not so close. In particular it would appear that the value of ν_{CT} for the naphthalene–iodine monochloride measured by Keefer and Andrews[2] is very high. Some of these variations may be due to differences arising from the perpendicular orientation of the acceptor in the complexes involving halogen molecules and the parallel orientation when the acceptor molecule is an aromatic or a quinone.

It may be noted that the variation of ν_{CT} with changing donor molecule is less in the complexes with iodine monochloride than in the complexes with iodine. This might be expected, as iodine monochloride is the weaker Lewis acid of the two. The reverse appears to hold, however, in the case of the *s*-trinitrotoluene and *s*-trinitrobenzene complexes, where *s*-trinitrotoluene is the weaker Lewis acid.

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Adsorption Chromatography on Silica-treated Paper

Paper partition chromatography is not successful with many organic compounds for two reasons: (1) the compounds have low solubility in water, and hence move on the solvent front in normal partition systems; (2) low reactivity of the compounds makes detection of the position of spots difficult.

To overcome the first of the difficulties, methods have been described which employ an organic solvent as the stationary phase on the chromatogram[1–3]. Alternatively, adsorption chromatography may be used instead of partition chromatography[4]. Also, Kirchner and Keller[5] have described the use of silica-treated paper for chromatography of dinitrophenylhydrazones.

The method here described has the convenience of paper chromatography, and may be used for a wide range of compounds difficult to chromatograph by partition methods. The chromatograms are run, with the solvents normally used in adsorption chromatography, on filter paper which contains approximately 20 per cent (w/w) of silica. Unreactive compounds are detected by the blue colour of the starch–iodine reaction, while other more reactive compounds may be detected by their own specific reactions.

The silica-treated paper is prepared as follows. Sheets of Whatman No. 1 filter paper (24 in. × 8 in. has been found a convenient size to handle) are passed slowly through a 25 per cent (w/v) solution of commercial sodium silicate in water and hung up to drain for approximately 30 min. It is essential that the paper is not allowed to dry at this stage. The papers are then passed slowly through a 3 *N* hydrochloric acid bath, and once again allowed to drain for 30 min. After draining, the papers are washed in running tap water for 2 hr. and finally hung up to dry overnight. Heating the dry paper in the oven at 100° C. for 15–30 min. before use activates the silica considerably, and produces better resolution on the chromatograms.

The mixture to be chromatographed is spotted on the paper in the usual way. It is preferable to use a volatile solvent for applying the mixture, as the applied spot must be free from moisture before the paper is placed in the chromatography tank. Chromatograms are developed by the ascending-flow method, in tightly sealed jars lined with filter paper saturated with the solvent. (Battery jars with ground-glass edges have been found suitable.) Light petroleum (b.p., 40–60° C.), benzene and chloroform have been found to be the most useful solvents for development of the chromatograms. The solvent front is allowed to ascend about 10–15 cm. before the chromatograms are removed.

Unreactive compounds are detected by dipping the dry chromatograms in a solution of iodine (1·5 per cent) in carbon tetrachloride, and allowing excess iodine to evaporate off the paper. A stream of air is useful in hastening this process. Compounds then show up as brown spots on a white background[6]. The spots may be intensified by dipping the iodine-treated chromatogram in 1 per cent starch solution, when blue spots of greater intensity are obtained. Any background of blue due to residual iodine may be removed by a brief exposure to sulphur dioxide gas.

The method has been successfully applied to the separation of many types of organic compounds, including terpenes, leaf pigments, phenolic ethers and esters, and steroids.

I am indebted to Dr. W. G. C. Forsyth, director of the Colonial Microbiological Research Institute, for helpful advice, and to the Colonial Products Council for permission to publish this communication.

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Thermocell with Ion-exchange Polymer Electrolyte

Recent communications[1,2] have described some thermocells in which two electrolyte solutions in contact with reversible electrodes are separated by an ion-exchange resin barrier. The ion-exchange resin in our apparatus is the sole electrolyte in physical contact with two identical copper electrodes and behaves as a solid electrolyte. The theoretical development of thermocells[3] is then applicable in an especially simple form.

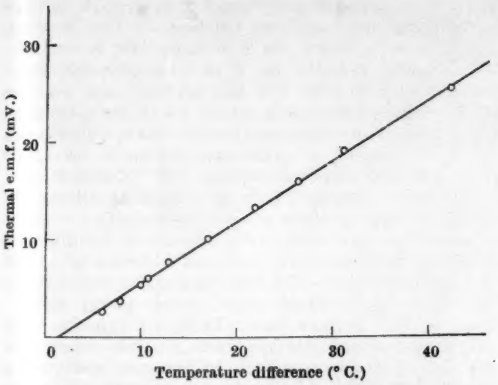

Fig. 1. Thermal electromotive force *vs.* temperature difference for the thermocell (*t*)Cu/Cu^{2+} ion-exchange resin/Cu($t + \Delta t$), where $t = 2{\cdot}5 \pm 2{\cdot}5°$ C. The cell dimensions are: *A*, 12 cm.²; *d*, 0·07 cm. The cold electrode is the anode; the electrolyte is saturated with water

The cell was constructed by pressing the ion-exchange resin in the form of a flat sheet between machined surfaces of copper. The electrolyte itself was an ion-exchange membrane, 'Nepton' *CR*–51 (unbacked type, Ionics, Inc., Cambridge, Mass.), consisting of a condensation polymer of phenol sulphonic acid and formaldehyde. This membrane had been converted into the leached copper-ion state by equilibration in five successive 2 *N* copper sulphate solutions of 100 times the membrane volume followed by long rinsing in distilled water. It is presumed that the membrane thus prepared contains copper ions in such amount that their charges exactly compensate the fixed negative sulphonate groups on the polymeric matrix. The transference number of copper ions in this electrolyte is unity.

The massive copper plate electrodes were maintained in intimate thermal contact with a stream of water at various controlled temperatures on the hot side and a rapidly stirred water-ice bath on the cold side. Measurement of Δt was accomplished by means of a differential copper-constantan thermocouple. The thermocell potentials were measured using an accurate potentiometer to the nearest 0·1 mV.

The results of three sets of measurements employing different samples of the ion-exchange polymer have yielded values 0·59, 0·64 and 0·65 mV./°C. (average 0·63) for the thermal electromotive force of the cell. A typical set of results is shown in Fig. 1. The relation between potential and temperature difference is linear, but extrapolation reveals a small dissymmetry potential which may be caused by inhomogeneity in the ion-exchange resin.

The Soret effect for copper ions appears to be entirely prevented by the nature of the electrolyte, but diffusion of water under the influence of the thermal gradient can occur.

The present results are consistent with other information. It has been reported[5] that a copper thermocell containing an aqueous copper sulphate electrolyte (0·94 *M*) had a thermoelectric power of 0·96 mV./°C. with the high-temperature electrode as the cathode. The temperature coefficient of the ($Cu \rightarrow Cu^{2+} + 2e^-$) half-cell has recently been reported[6] to have the value −0·81 mV./°C. for copper solutions of unit activity and independent of the nature of the anion. Our results probably are indicative of an activity of copper ions less than unity. Holtan's treatment of thermocells could be applied to the present case if further information on the water transported by copper-ion migration[6] and the activity of copper ions in the ion exchanger were available. Evidence that the copper–copper ion-exchange membrane half-cells are probably reversible has already been obtained and will be reported elsewhere. Such ion-exchange thermocells may have some practical application as a temperature-sensing device.

I am indebted to Dr. H. A. Liebhafsky of this Laboratory for suggesting this type of ion-exchange thermocell.

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Synthesis of Succinate from Acetate by an Enzyme System of Pig Heart Muscle

The oxidation and condensation of two molecules of acetate to form succinate was first proposed by Thunberg[1]. Many later attempts have been made to demonstrate this reaction, with for the most part equivocal results. Recently, evidence has been presented[2] that the reaction does not occur in *E. coli*. On the other hand, evidence has been presented[3,4] that extracts of *Tetrahymena* catalyse the Thunberg reaction at a slow rate, and Seaman[5] has presented evidence that mammalian tissue catalyses the reduction of succinate to acetyl coenzyme A.

This report presents evidence that an enzyme system present in pig heart muscle catalyses the oxidation and condensation of acetate to form succinate.

The enzyme was prepared by extracting an acetone-dried powder of pig heart muscle with potassium phosphate buffer (0·1 *M*, *p*H 7·4) and fractionating with ammonium sulphate. The protein precipitated between 30 and 65 per cent saturation was dissolved in the minimum volume of potassium phosphate buffer (0·1 *M*, *p*H 8·0) and stored in the deep freeze at −18°. Activity was retained for at least four months.

When the enzyme was incubated under anaerobic conditions with acetate-2-^{14}C, adenosine triphosphate, magnesium, coenzyme A and glutathione, a number of radioactive spots were obtained (Fig. 1). Some of the compounds have been identified as S-acetyl-coenzyme A and S-acetyl glutathione, but the compound with an R_F of 0·55 in butanol/formic acid/water has not yet been identified. The radioactive compound with the highest R_F was identified as succinate by the following criteria: (1) Chromatography and co-chromatography in the following solvents: butanol/formic acid/water; tertiary amyl alcohol/formic acid/water; propanol/ammonia/water; ethanol/ammonia/water and phenol. (2) Two dimen-

sional co-chromatography in tertiary amyl alcohol/formic acid/water and ethanol/ammonia/water. (3) Oxidation by succinoxidase prepared from pigeon breast muscle. The products of the oxidation were identified as fumarate and malate (Fig. 2).

The radioactivity incorporated into succinate is small, but is increased several-fold by the addition of oxidized glutathione or acetaldehyde diphosphopyridine nucleotide and alcohol-dehydrogenase to serve as hydrogen acceptors (Table 1).

Table 1. Effect of Hydrogen Accepting Systems on the Formation of Succinate from Acetate-2-^{14}C. Reaction Mixture as in Fig. 1. Incubation at 30° for 2·5 hr.

Conditions	Counts per min. in succinate
No additions	1,560
Oxidized glutathione 10 μmoles	5,800
Oxidized glutathione 10 μmoles Acetaldehyde 20 μmoles, coenzyme I 0·1 μmole, alcohol dehydrogenase 0·1 mgm.	7,220

The physiological significance of the enzyme system is uncertain. The very slow rate of succinate formation from acetate (0·07 μmole succinate/hour/10 mgm. protein) agrees with the results of Seaman, who suggests that the enzyme may function by splitting succinate. However, many biological dehydrogenations are driven against an energy barrier by coupling to the electron transporting system. Consequently, coupling the Thunberg condensation to the electron transporting system should increase the formation of succinate. Preliminary experiments with pigeon liver mitochondria show that when succinate oxidation is blocked by malonate there is a 10 per cent incorporation of acetate in succinate. It is thus possible that, in the conversion of fats to carbohydrates[6], the Thunberg condensation serves as an alternative reaction to that catalysed by malate synthetase[7]. In this context it is perhaps relevant that malate synthetase has not been demonstrated in animals[8].

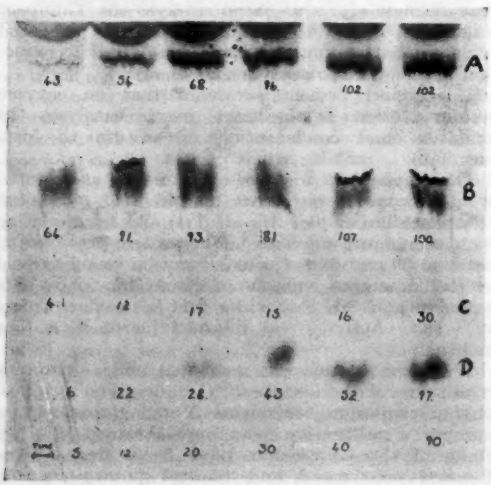

Fig. 1. Radiochromatogram demonstrating the formation of succinate from acetate-2-^{14}C. Reaction mixture potassium acetate (10 μmoles), acetate-2-^{14}C (10^5 counts per min.), magnesium chloride (5 μmoles), adenosine triphosphate (10 μmoles), glutathione (50 μmoles), coenzyme A (0·1 μmole), *tris* buffer pH 8·0 (0·1 *M*), enzyme (0·2 ml.), total volume 2 ml. Anaerobic conditions, bath temperature 35°. Samples (0·2 ml.) removed at times indicated and after removal of protein applied to filter paper chromatograph and run in butanol/formic acid/water. Figures under radioactive areas give counts per min. *A*, Acetyl coenzyme A; *B*, acetylglutathione; *C*, unknown; *D*, succinate

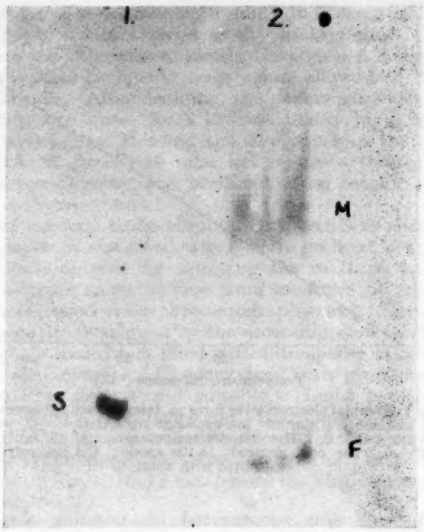

Fig. 2. Radiochromatogram demonstrating that the radioactive compound, identified as succinate, gives fumarate and malate labelled with carbon-14 after oxidation with succinoxidase. Line 1, Succinate before oxidation; line 2, products after oxidation with succinoxidase. Solvent system tertiary amyl alcohol/formic acid/water. *M*, Malate; *S*, succinate; *F*, fumarate

I am indebted to Prof. T. A. Bennet-Clark, Sir Hans Krebs and Dr. H. L. Kornberg for valuable discussion and advice.

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N-Terminal Amino-acids of Bovine Eye Lens Proteins

The proteins of the crystalline lens are of particular significance to the embryologist because of the (serological) organ specificity of this part of the eye. In connexion with other biochemical and serological studies in our laboratory an investigation is being made on the N-terminal amino-acids of the main lens proteins: α-, β- and γ-crystallin. The preparations of α-crystallin have been isolated mainly by zone electrophoresis on starch[1]. They showed one single peak in both paper electrophoresis and moving-boundary electrophoresis at *p*H 4·2; 6·2; 7·1; 7·8; and 8·9 respectively. In the ultracentrifuge only a very small percentage of impurities was still noticeable. Some preliminary experiments were also made on β- and γ-crystallin, which preparations were obtained by salting out with ammonium sulphate and still showed small amounts of impurities when investigated by electrophoresis and ultracentrifugation.

For the end-group determinations Sanger's dinitrofluorobenzene method, as described by Fraenkel-

Conrat, Harris and Levy[2] was mainly used. The dialysed and freeze-dried proteins were dissolved in portions of 200 mgm. in 9 ml. water, and 300 mgm. dinitrofluorobenzene in 6 ml. ethanol added. The mixture was kept at *p*H 8·1 with 0·05 *N* sodium hydroxide added by means of an autotitrator. From the alkali uptake during the reaction it was found that, at room temperature, a period of 7 hr. was necessary for completing the reaction with α-crystallin. The dinitrophenyl–protein remained in solution; spectrophotometric analysis prior to hydrolysis showed dinitrophenyl–proline and –hydroxyproline to be absent. By using performic acid oxidation cystine could also be excluded as N-terminal amino-acid.

After precipitation with hydrochloric acid, the dinitrophenyl–α-crystallin was washed out as usual with water, ethanol, ether and ethyl acetate to ensure a complete removal of dinitrophenyl–peptides that might be present together with salts and excess reagent. Hydrolysis was carried out by heating at 110° C. with 5·7 *N* hydrochloric acid in sealed evacuated tubes for 8 hr. For the determination of dinitrophenyl–ε-lysine a hydrolysis time of 72 hr. was necessary.

For paper chromatography Whatman No. 52 paper was used.

In the water-soluble fraction of the hydrolysate only dinitrophenyl–ε-lysine was present, in a quantity of 21 moles per 100,000 gm. dinitrophenyl–α-crystallin. In the ether-soluble fraction the following dinitrophenyl–amino-acids were found in α-crystallin (Table 1).

Table 1. N-TERMINAL AMINO-ACIDS IN α-CRYSTALLIN

Dinitrophenyl-amino-acid	R_F*	R_F†	Mol. dinitrophenyl-amino-acid per 100,000 gm. dinitrophenyl-protein‡
Glutamic acid	0·01	0·49	1·00
Serine	0·12	0·43	0·12
Glycine	0·18	0·27	0·07
Alanine	0·27	0·37	0·05
Threonine	0·18	0·42	0·02

* R_F toluene system of Biserte *et al.*, as modified by Levy (ref. 3).
† R_F phosphate buffer (Levy, ref. 3).
‡ Corrected for losses during the procedure.

The very small quantities of dinitrophenyl derivatives of serine, glycine, alanine and threonine may represent either impurities still present in the preparations or terminal groups resulting from partial breakdown of the peptide chain.

An interesting result of the preliminary experiments on the other fractions, β- and γ-crystallin, was that the same N-terminal amino-acids (mainly glutamic acid) were found to be present, although in different proportions. This might be an expression of organ specificity of these proteins. The experiments are being continued.

We are grateful to Prof. H. Gerding for his interest and critical discussions; thanks are also due to Dr. W. F. Bon for carrying out the ultracentrifuge experiments and to Mr. H. P. Wijnand for assistance with electrophoresis.

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A Histoautoradiographic Study of the Effect of Section of the Facial Nerve on the Uptake of Methionine-^{35}S by the Cells of the Facial Nerve Nucleus

RETROGRADE degeneration of nerve cells was first described by Nissl in 1892[1]. Its main features are swelling of the cells, breaking up of the cytoplasmic chromophile granules and displacement of the nucleus to the cell margin. These changes occur after a lesion in the axon, after excitation of long duration or after certain virus diseases, as, for example, poliomyelitis. It is still not known whether these changes are entirely degenerative in nature or are due to increased metabolic activity associated with increased synthesis of protein molecules. The biochemical processes underlying these changes have so far not been adequately explained. The results obtained from ultra-violet microspectrography of the nucleic acid content of these cells have not been entirely satisfactory[2].

The present communication deals with the results obtained by studying the incorporation of methionine-^{35}S into the affected nerve cells. In a previous investigation[3], it was found that methionine-^{35}S becomes incorporated to a larger extent in the grey matter than in the white matter, and this is in agreement with the findings of other workers[4]. Twenty-four hours after the administration of methionine-^{35}S, 98 per cent of the amino-acid in the brain has become bound to the protein of the central nervous system. The degree of incorporation of methionine-^{35}S therefore indicates the protein synthetic activity of the respective structure.

Five rabbits weighing 3–3·5 kgm. were used for the present investigation. The facial nerve on one side was cut in each animal at a distance of about 3 mm. from the stylo-mastoid foramen. After thirteen days, 500 μc. of methionine-^{35}S was injected intraperitoneally into each animal. All the animals were killed 24 hr. later and the pons and medulla oblongata were removed and fixed in 96 per cent alcohol and then embedded in paraffin wax. The isotope content of all the liquids used in processing the tissues was measured and no activity was found. Histological sections of the facial nerve nucleus area were then prepared so that in one section there were the nuclei of both the injured and the normal facial nerves. The histoautoradiographic 'coating method' was used, the emulsion being prepared as described previously[5]. The duration of exposure was 61 days. The sections were kept in an exsiccator at 4° C. The developed sections were then stained with hæmatoxylin and eosin using the Bélanger method[6].

The degree of blackening of the emulsion coating the section indicated the concentration of the radioactive amino-acid in the section. Photographs of retrograde degenerated cells of the injured seventh nerve nucleus as well as photographs of cells of the normal nucleus were then taken. Photographs were also taken of the emulsion coating at corresponding levels just above these cells. By subtracting the degree of blackening over the surrounding tissues from the amount of blackening over a cell of the seventh nerve nucleus, a value of the incorporation of methionine-^{35}S into the cell of the nucleus was obtained. In addition, the area of each cell was calculated by means of a planimeter. The results were then evaluated statistically.

It was found that more methionine-^{35}S was incorporated into the nerve cells than into the surrounding

white matter, thus confirming previous observations. In all the sections the nerve cells of the denervated seventh nerve nucleus had incorporated significantly more methionine-^{35}S than the cells in the normal control nerve nucleus. The planimeter measurements showed that the area of the nerve cells of the denervated nerve nucleus was in most cases greater than the area of the nerve cells of the control nucleus. The nerve cells of the denervated nucleus incorporated per unit area more methionine-^{35}S than the corresponding area of the cells of the control nucleus.

The results therefore show that nerve cells undergoing retrograde degeneration have an increased uptake of methionine, indicating that an increased synthesis of protein molecules is taking place.

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Perosis and Folic Acid Antagonism in Chickens

The folic acid antagonist pyrimethamine has been shown to act as a synergist with sulphadimidine against *Eimeria tenella* in chickens[1]. During our investigation of this combination, a decreased growth-rate was noted in chickens fed for five days on an all-mash diet containing 100 p.p.m. of pyrimethamine.

The toxicity of pyrimethamine was therefore examined with four groups of forty chickens which were fed mash containing pyrimethamine 0, 25, 50 or 100 p.p.m. from 7 days of age. The growth-curves are shown in Fig. 1. During the first fourteen days feeding, one chicken fed 25 p.p.m. and two fed 100 p.p.m. died of pyrimethamine poisoning. After fourteen days feeding two chickens were selected at random from each group for hæmatological study. The remainder of each group was randomized by weight into two even sub-groups, one chicken in the group fed 25 p.p.m. being discarded. One sub-group continued on the medicated feed and the other sub-group was fed basal ration. The chickens fed basal ration quickly resumed normal growth. In this period six chickens fed 100 p.p.m. died of pyrimethamine poisoning.

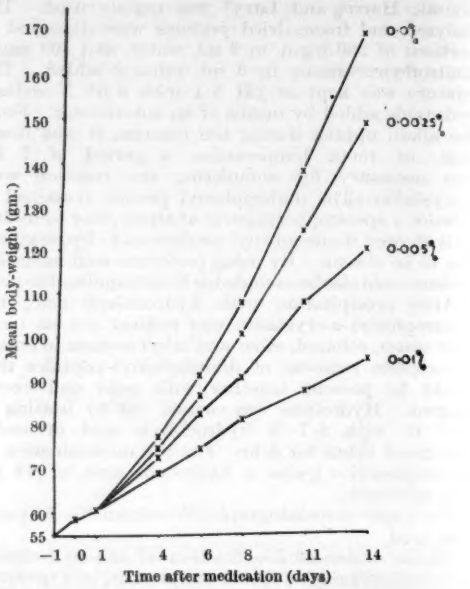

Table 1. Mean Weight Gains, Number of Deaths and Incidence of Perosis in Chickens fed Pyrimethamine 0, 25, 50 or 100 p.p.m. for 14 or 32 Days

Pyrimethamine in diet (p.p.m.) 0–14 days	15–32 days	Mean gain in weight (gm.) after 14 days	32 days	Cases of Perosis	Death
0	0	113	393	0/19*	0
	0		370	0/19	
25	0	93	361	2/18	1
	25		331	11/18	
50	0	64	307	2/19	0
	50		212	19/19	
100	0	40	260	6/18	8
	100		101	13/15†	

* Number of cases of perosis/number in group.
† Three of these died late in the experiment and were examined for perosis.

Perosis was seen in the medicated groups after twenty-five days feeding. At thirty-two days all chickens were examined for perosis, and Table 1 shows the incidence in the various groups. Some chickens fed 25 p.p.m. pyrimethamine for only fourteen days showed perosis. The diet contained ¼ oz. anhydrous manganese sulphate per 100 lb. mash and was calculated to contain 80 p.p.m. of manganese.

Daniel, Farmer and Norris[2] showed that perosis occurred in chickens fed a diet low in folic acid and was prevented by adding synthetic folic acid to the diet. The addition of succinyl sulphathiazole accentuated the severity of the perosis on a diet low in folic acid. This seems to support the theory that chickens synthesize folic acid from *p*-aminobenzoic acid, which is made by the degradation of folic acid in the diet[3].

In our work, it seems certain that the perosis was due to a deficiency of folic acid caused by pyrimethamine, a potent folic acid antagonist.

A detailed account of these experiments will be published elsewhere.

I am grateful to Burroughs Wellcome and Co. (Australia), Ltd., who generously provided a quantity of pyrimethamine.

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A Comparative Biochemical Study of Nucleohistones from Different Vertebrates

RESULTS recently reported by Crampton *et al.*[1] lead those authors to the conclusion that the nucleohistones extracted from the different tissues of the same animal are very similar in composition. Our own investigations on different organs of the calf confirm these results (Table 1, Fig. 1).

Table 1. AMINO-ACID RESIDUE (GM.) PER 100 GM. PROTEIN

	Calf thymus histone	Calf liver histone	Calf kidney histone
Arginine	12·6	11·8	12·3
Lysine	15·5	15·2	16·1
Histidine	2·4	2·5	2·3

in all these nucleohistones were also determined (Table 2).

This comparison reveals a striking similarity between all the nucleohistones studied, so it appears that if differences do exist between the histones of the various animals, they are beyond the sensitivity of our analytical technique. The classical results of Chargaff[2], at least concerning vertebrates, on the analysis of deoxyribonucleic acid from different organs of an animal and the same organ in various animal species (mammals, birds, fishes and reptiles) fail to reveal very marked differences between these deoxyribonucleic acids, though the slight differences detected could be significant. In the nucleohistone a similarity of general composition seems to occur in

Table 2. AMINO-ACID RESIDUE (GM.) PER 100 GM. PROTEIN

	1	2	3	4	5	6	7	8
	Carp erythrocyte histone	Trout erythrocyte histone	Pike erythrocyte histone	Calf thymus histone	Fowl erythrocyte histone	Duck erythrocyte histone	Tench erythrocyte histone	Frog erythrocyte histone
Arginine	13·5	13·5	11·4	12·6	13·3	13·0	—	12·8
Lysine	15·0	15·2	13·5	15·5	16·0	15·7	—	14·0
Histidine	2·3	2·5	1·9	2·4	2·5	2·4	—	2·9

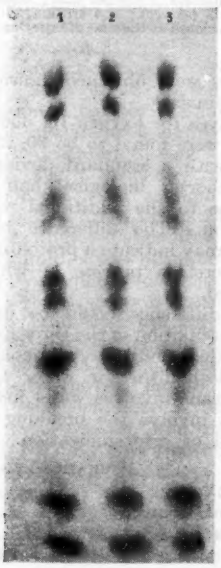

Fig. 1. Chromatograms of nucleohistones extracted in *M* sodium chloride from calf thymus, liver and kidney. Hydrolysates containing identical quantities of deoxyribonucleic acid were used in all three cases. Whatman paper No. 1. Solvent: 4 parts, butanol; 1 part, ethanol; 1 part, acetic acid; 2 parts, water

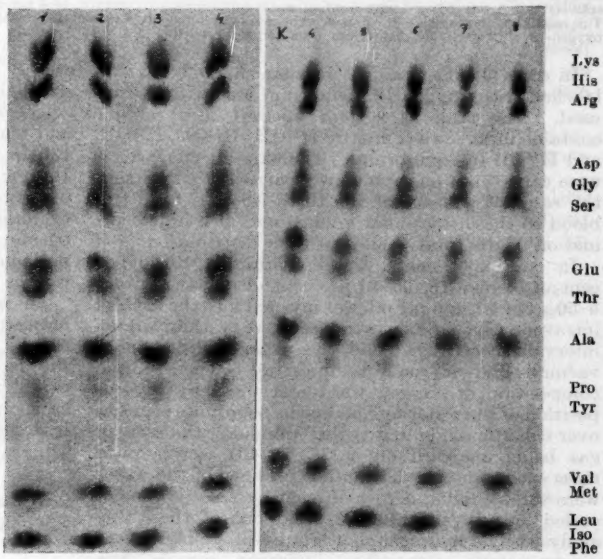

Fig. 2. Chromatograms of nucleohistones from different vertebrates (each volume of hydrolysate corresponds to the same quantity of deoxyribonucleic acid. Nucleohistone from: (1) carp erythrocytes; (2) trout erythrocytes; (3) pike erythrocytes; (4) calf thymus; (5) fowl erythrocytes; (6) duck erythrocytes; (7) tench erythrocytes; (8) frog erythrocytes. Whatman paper No. 1. Solvent: 4 parts, butanol; 1 part, ethanol; 1 part, acetic acid; 2 parts, water

But a comparison of nucleohistones extracted from different animal species is also of interest. For that reason, we have studied nucleoproteins isolated by the technique of Signer and Schwander[2] from different materials, namely, calf thymus and erythrocytes of carp, trout, pike, tench, frog, fowl and duck. Chromatograms were made of all these nucleohistones. Before chromatography, the hydrolysates were adjusted to identical content of deoxyribonucleic acid, in order to permit an easy comparison of the chromatograms run in parallel on the same paper (Fig. 2). The amounts of arginine, lysine and histidine the samples studied, and reflects the similarity of the general composition of the nucleic acids.

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Rate of Body-Water Distribution studied with Triple Labelled Water

The rate of equilibration of extra- and intracellular water is determined by the passage of the water through the cell membrane. The transfer of water through cell membranes can proceed by various mechanisms. The simplest mechanism is diffusion of water molecules as a whole. Another mechanism is a biological carrier system, such as exists, for example, in the tubular mechanism of the kidney; and another route of transfer is ionic migration of protons and hydroxyl ions independently through the cell membrane.

Our results show that, within the experimental accuracy, no difference could be found in the rates of distribution of the three isotopes and their respective volumes of distribution (Fig. 1). (The standard deviations for the determination of oxygen-18, deuterium and tritium were 1, 2 and 2 per cent respectively.) The percentage of body water in our measurements is in full agreement with values obtained with deuterium as a tracer[2]. The small differences in fluid volumes of distribution could be explained either by the different rates of exchange between these isotopes and body constituents on one hand and the different routes of excretion on the other. Different results were obtained, however, in deeply anæsthetized animals.

Table 1. Volume of Distribution of Labelled Water in Rabbits

Rabbit No.	Time after injection (min.)	Isotopic composition of blood samples: Oxygen-18 (per cent)	Deuterium (per cent)	Tritium (μc.)	Volume of distribution from isotope dilution*: Oxygen-18 (ml.)	Deuterium (ml.)	Tritium (ml.)
U2	2·5	0·267	0·168	$2·5 \times 10^{-2}$	1,260	1,235	1,278
U2	10	0·260	0·151	$2·25 \times 10^{-2}$	1,415	1,392	1,420
U2	29	0·254	0·140	$2·07 \times 10^{-2}$	1,560	1,517	1,542
U2	140	0·250	0·129	$1·98 \times 10^{-2}$	1,670	1,665	1,615
A–3	4	0·274	0·235	$1·40 \times 10^{-1}$	1,320	1,295	1,250
A–3	40	0·262	0·210	$1·15 \times 10^{-1}$	1,570	1,545	1,525

* *U2* was injected with 5 ml. of water containing: oxygen-18, 18·6 per cent; deuterium, 37·6 per cent; and tritium, 6·4 μc./ml. The isotopic composition of the blood was found to be before injection: oxygen-18, 0·195 per cent; deuterium, 0·016 per cent; tritium, zero activity. *A*–3 was injected with 5 ml. of water containing: oxygen-18, 18·4 per cent; deuterium, 40·3 per cent; and tritium, 33·3 μc./ml. This rabbit had been used in previous experiments so that its body water (blood) was slightly isotopically enriched at the time of injection, namely oxygen-18, 0·20 per cent; deuterium, 0·08 per cent; tritium, $5·4 \times 10^{-3}$ μc./ml.

In order to elucidate the mechanism, water triply labelled with oxygen-18, deuterium and tritium was used. The aqueous system injected into rabbits contained therefore primarily $H^{16}OH$, $H^{16}OD$, $H^{18}OH$ and $H^{18}OD$ in equilibrium. The experiments, which were carried out on rabbits, were aimed at comparing the rates of transfer of the three isotopes from the blood to the intracellular volume and at the determination of the total volume of their distribution.

In our experiments, water containing 16–20 per cent of oxygen-18, 35–45 per cent of deuterium and 5–50 μc. of tritium per ml. was injected into the rabbits intravenously. Blood samples were withdrawn at intervals, centrifuged and the water distilled on a vacuum line at room temperature. The isotopic composition of oxygen was determined by decomposition of the water by alkaline hypobromite solution over cobaltic oxide in a sealed ampoule[1], the oxygen gas being analysed on a *CEC*21–401 isotope-ratio mass spectrometer. Two other portions of the water were totally reduced to hydrogen by zinc powder in sealed ampoules at 400° C., and one of these was analysed by a hydrogen/deuterium isotope-ratio mass spectrometer; the other hydrogen sample was introduced into a Geiger counter for activity determination. Some typical results are shown in Table 1.

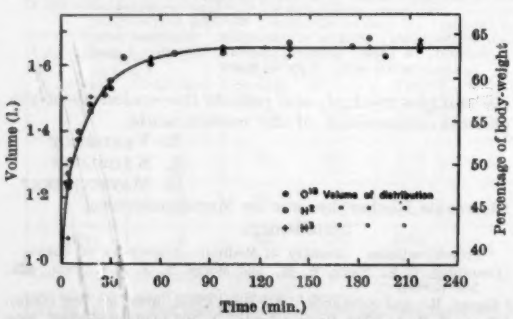

Fig. 1. The rate of distribution of water labelled with oxygen-18, deuterium and tritium as a function of time

The biological half-lives for oxygen-18, deuterium and tritium in rabbits were found to be 80, 220 and 130 hr. respectively (with a standard deviation of 10 per cent). The shorter biological half-life of oxygen-18 may be due to the additional route of excretion by expiration. The difference between tritium and deuterium may indicate a proton-transfer mechanism in the excretion process in which an isotope effect is involved.

As no appreciable difference could be detected between the rates of distribution of the three isotopes, it may be concluded that under normal conditions the most probable mechanism for water transfer through the cell membrane involves water molecules as such, and does not involve the breaking of the hydrogen–oxygen bond or prior ionization.

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Radioprotective Properties of Cystamine, Cysteamine and Cysteine when tested with Chick Fibroblasts *in vitro*

It is well known that a number of SH-containing compounds afford a certain amount of radioprotection to many organisms[1,2]. However, little information is available about the effects on cells *in vitro*. The present report deals with a series of experiments on the effects of cystamine, cysteamine and cysteine when added to cultures of chick fibroblasts shortly before irradiation.

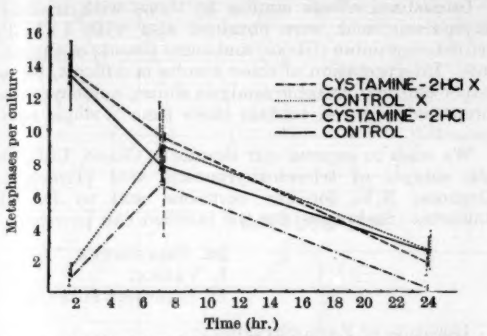

Fig. 1. Number of metaphases in hanging-drop cultures after treatment with 0·44 m*M* cystamine–2 hydrochloride and 200r. X-rays. The number of cultures for each point is 12 in the non-irradiated controls and 6 in the other groups

Heart fibroblasts from 9-day-old chick embryos were cultivated in standard media either in hanging drops or in Carrel flasks. The test substances were added in Tyrode solution, and the cultures were irradiated 15 min. later with 175 kV. X-rays, 0·5 mm. copper filtration, tissue dose-rate 50–100 r./min., under conditions of maximum back-scatter, in a water or air thermostat.

Mitotic inhibition was investigated in hanging-drop cultures. After 48 hr. in the second passage after explantation a non-toxic solution of 0·11 m*M* or 0·44 m*M* cystamine–2 hydrochloride or 0·21 m*M* cysteine–hydrochloride was added before irradiation with 200r. Prophases, metaphases, anaphases and telophases were counted in stained cultures, fixed 80 min. 4 hr., 7 hr. or 24 hr. after irradiation. The results obtained show that the radiation-induced mitotic inhibition was not influenced by the addition of either cystamine or cysteine in the above concentrations. Fig. 1 shows a typical response pattern.

Growth inhibition was investigated in cultures which were grown in Carrel flasks. When the explants had been cultured for four days, the liquid phase was substituted with test solution or Tyrode, and the cultures were irradiated. After irradiation the cultures were washed, and new liquid phase was added. Three days after treatment, the cultures were transferred to hanging drops and grown for 10–15 passages. At the end of every passage, each culture was scored as living or dead, the area of the growth migration zone was measured, and throughout the experiment the same person evaluated the vigour of each culture. Several concentrations of cystamine–2 hydrochloride, cysteamine–hydrochloride and cysteine–hydrochloride were tested after 1,500, 2,000 and 3,000r. After irradiation with such doses, the cultures deteriorate rapidly during the first 4–6 passages, after which most die in the next 5–10 passages.

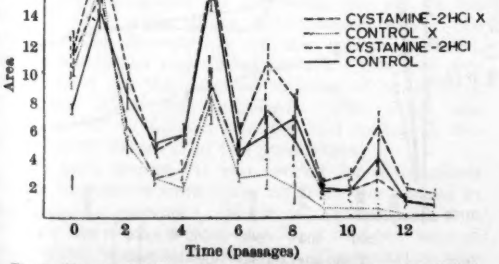

Fig. 2. Change with time of average area for 12 cultures irradiated with 1,500r. after addition of 0·89 m*M* cystamine–2 hydrochloride and controls, with standard deviation of the mean. × = irradiated groups

The results obtained show that the addition of 0·89 m*M* cystamine–2 hydrochloride before irradiation with 1,500 or 2,000r. helps the cultures through the critical phase which seems to occur after 4–6 passages. After this point the 'protected' cultures do better than the controls, having more survivors, a larger growth zone, and giving a more healthy impression. Fig. 2 shows average growth-zone areas from a typical experiment. It will be noted that the two groups of irradiated cultures have about the same area in the first 6 passages, but that during the subsequent passages the cultures receiving cystamine approach the non-irradiated controls. There is also a certain difference to be seen between the two groups of non-irradiated cultures. For cysteamine–hydrochloride or cysteine–hydrochloride no similar protective effect could be found.

The observed effect of cystamine may be explained as a result of one or more mechanisms operating during and immediately after irradiation[3,4]. However, the effect may also be attributed to a general growth-promoting property of cystamine in the concentration used. A combination of these two explanations is also possible.

A complete report will be published in the twenty-fifth anniversary publication of the Norwegian Radium Hospital.

The technical assistance of Miss Brit Falck Madsen and Miss Gudrun Braarvig is gratefully acknowledged. The investigation has been supported by the Norwegian Cancer Society.

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Immediate Effect of *l*-3 : 5 : 3′-Tri-iodothyroacetic Acid on Metabolic Rate and Body Temperature in Hypophysectomized Rats and the Action of Cortisone

The acetic acid analogues of thyroxine and tri-iodothyronine have been found to raise the metabolic rate of the thyroidectomized[1–4] and the hypophysectomized[2,4] rat without latency. In hypophysectomized rats intravenous injection of a few micrograms of tri-iodothyroacetic acid is invariably followed by a marked rise in oxygen consumption and body temperature, while only about half the thyroidectomized and none of the intact rats show a similar response[4].

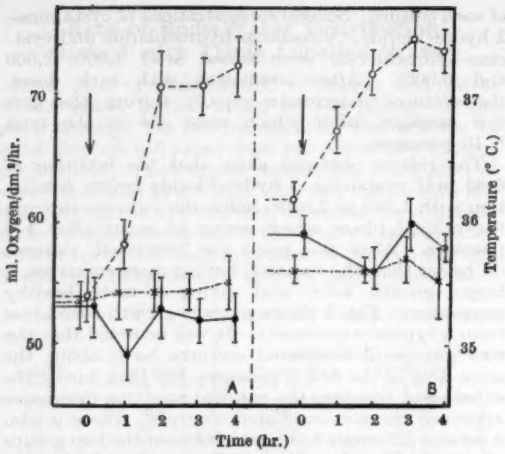

Fig. 1. Effect of 5 μgm. tri-iodothyroacetic acid injected intravenously on oxygen consumption (*A*) and body temperature (*B*) in the hypophysectomized rat ($n = 23$), O — — — O; in the cortisone-treated hypophysectomized rat ($n = 10$), ×—.—.—×. Effect of 0·2 ml. solvent on oxygen consumption (*A*) and body temperature (*B*) of the hypophysectomized rat ($n = 10$), ●——●

Experiments performed a few weeks after removal of the pituitary in adult male rats, and summarized in Fig. 1, demonstrate the marked rise in oxygen consumption and body temperature following intravenous injection of 5 μgm. of tri-iodothyroacetic acid (Glaxo), and show that both effects are completely abolished by 1 mgm. of cortisone (Organon) administered three hours earlier. (In some experiments a single cortisone injection was given, in others the rats received 1 mgm. daily for 2–3 days, the last being administered three hours before injecting tri-iodothyroacetic acid.) Injection of the solvent had no effect, nor did cortisone abolish the effect of a highly purified pyrogen[5], so that contamination with pyrogen can be excluded.

A large number of old and new observations tend to show an interaction of the thyroid and the adrenal gland[6], but, with the exception of adrenal hypertrophy in hyperthyroidism and atrophy in hypothyroidism and their experimental counterparts, the results are not very conclusive, and mainly concern the action of corticosteroids on the secretion of thyroid-stimulating hormone. The present experiments seem to be the first to demonstrate that a corticosteroid interferes with the action of a iodothyronine derivative.

That lack of adrenal cortical function is an essential condition for the manifestation of an immediate effect of tri-iodothyroacetic acid on oxygen consumption and body temperature is supported by the following observations. (1) No immediate response can be obtained in the hypophysectomized rat adequately treated with adrenocorticotrophic hormone. (2) An immediate response was elicited in all adrenalectomized rats, which later, after the withdrawal of sodium chloride, died of adrenal insufficiency. (3) The immediate response can be observed sixteen hours after the removal of the pituitary. (4) The immediate response in the hypophysectomized rat is not abolished by elevating the reduced metabolic rate to a normal or even high level by the administration of thyroxine.

Adrenal hypofunction may possibly be an adequate explanation for the less regular incidence of the immediate response in the thyroidectomized rat.

Immediate effects similar to those with tri-iodothyroacetic acid were obtained also with 3 : 5 : 3′-tri-iodothyronine (Glaxo) and some brands of thyroxine. Interpretation of these results is difficult, for as paper chromatographic analysis shows, iodothyronine preparations often contain more than a single compound[3,7].

We wish to express our thanks to Glaxo, Ltd., for the sample of tri-iodothyroacetic acid (Triac), to Organon N.V. for the cortisone and to Dr. O. Lüderitz (Säckingen) for the purified coli pyrogen.

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Distribution of Carbon-14 in Components of Goat's Milk, with Sodium Formate-^{14}C as Precursor

In a report dealing with the biosynthesis of milk components by the cow, Kleiber[1] described the use of sodium formate labelled with carbon-14 as one of the precursors. This communication reports the transfer of carbon-14 to the components of goat's milk when formate was the precursor.

A grade goat was injected intravenously with 30 mc. of sodium formate-^{14}C (Tracerlab) dissolved in 10 ml. of saline (0·85 per cent). Prior to dosing the animal, residual milk was removed from the

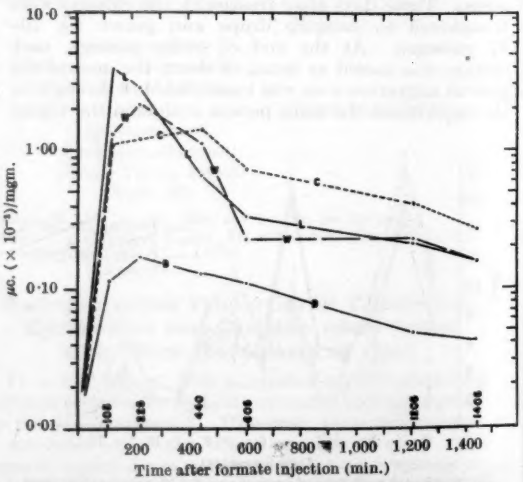

Fig. 1. Specific activity of milk components: ·—*B*—·, butterfat activity; ·----*C*----·, casein activity; ·—*L*—·, lactose activity; ·—*W*—·, whey-protein activity

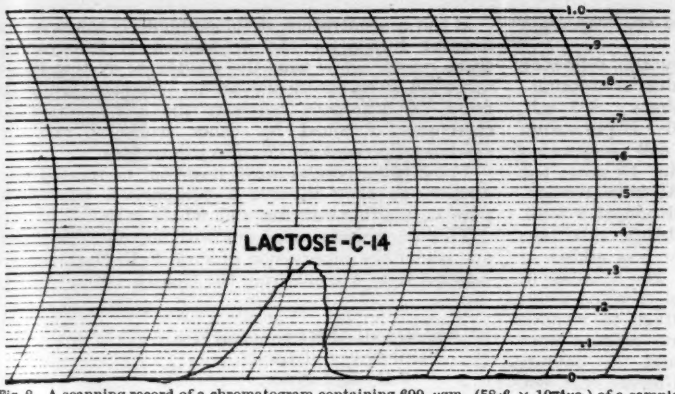

Fig. 2. A scanning record of a chromatogram containing 600 μgm. ($58{\cdot}6 \times 10^{-4}$ μc.) of a sample of lactose-^{14}C

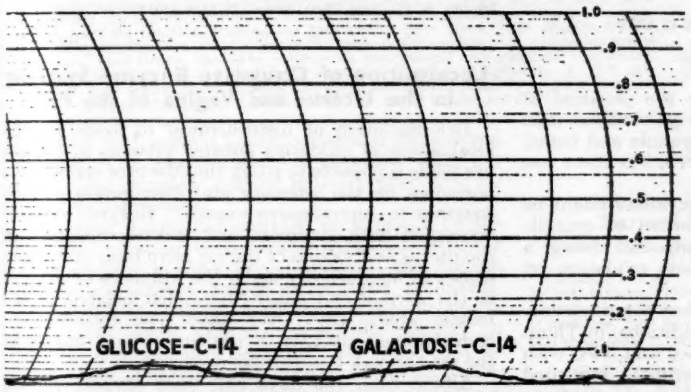

Fig. 3. A scanning record of a chromatogram containing 100 μgm. ($38{\cdot}7 \times 10^{-4}$ μc.) of a sample of lactose-^{14}C hydrolysed with 0·5 *N* sulphuric acid at 100° C. for 4 hr.

udder by injecting oxytocin (Squibb), 10 U.S.P. units per dose, and milking one minute later. Four such milkings were made over a period of 6·5 hr.

The goat was milked 5, 105, 225, 440, 605, 1,205 and 1,445 min. after the injection of formate. (The injection of formate and milking of the goat were done at the University of Maryland, College Park, Maryland, by J. C. Shaw, S. Lakshmanan and T. R. Lewis.) Oxytocin was used each time to stimulate the flow of milk. Each batch of milk was immediately frozen in 'dry ice', and held in the frozen state until it was fractionated.

After thawing the milk at 40° C., butterfat was separated by centrifugation and casein was precipitated at the isoelectric point. Precipitable whey–protein was separated by adjusting the *p*H of the whey to 4·0 with dilute hydrochloric acid. To facilitate the flocculation of the serum proteins, sodium bisulphite was added on a 0·1 per cent w/v ratio, based on the original volume of milk from which the whey was obtained[2]. The whey was heated at 95° C. for ten minutes and cooled to 20–30° C. before removal of the precipitate.

Since pure lactose-^{14}C was needed for metabolism studies, impurities were removed from the lactose in the following manner: 'Norit *A*' (Pfanstiehl) was added to the crude lactose at a level of 3 per cent of the original whole-milk volume. The mixture was heated to 95° C., centrifuged for 5 min. at 2,000 r.p.m. and decanted on to Whatman No. 5 filter paper. The filtrate was concentrated by evaporation on a steam-bath and was then freeze-dried. The lactose was dissolved in small quantities of boiling water, and the temperature was lowered gradually to −5° C. Methanol (two volumes) was added to reduce the solubility of the lactose, permitting crystallization at −5° C. in 48 hr. The crystals of lactose were then washed with methanol and dried with ether.

All samples for assay were combusted by the method of Gabourel[3], and carbon-14 was counted as $Ba^{14}CO_3$. As shown in Fig. 1, the specific activity of the lactose reached a maximum value 105 min. after the injection of the precursor, whey–protein and butterfat at 225 min., and casein at 440 min.

A sample from each batch of lactose was paper-chromatographed and scanned[4] for the detection of radioactive impurities. Samples showing radioactive contamination were recrystallized until the interfering activity was eliminated (Fig. 2). A sample of the purified lactose was hydrolysed with 0·5 *N* sulphuric acid in a sealed tube for 4 hr. at 100° C. The hydrolysate was adjusted to *p*H 4·5 with a saturated solution of barium hydroxide, filtered, condensed, chromatographed and scanned. The scan showed that the activity was equally distributed between the glucose and galactose moieties (Fig. 3).

We are grateful to Drs. A. Edelmann, Nuclear Science and Engineering Corp., Pittsburgh, and R. Steele, Brookhaven National Laboratory, Upton, New York, for their suggestions during the planning of some phases of this experiment.

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Occurrence of Rhodanese in a Species of *Thiobacillus*

The enzyme rhodanese which catalyses the reaction:

$$S_2O_3'' + CN' \rightarrow CNS' + SO_3$$

has been shown to be present in *Thiobacillus thiocyanoxidans*. Cells of the organism, grown in thiosulphate medium with forced aeration and 2–5 per cent of carbon dioxide added[1], were harvested in a

de Laval centrifugal separator, washed and suspended in *M*/15 phosphate buffer, *p*H 7·0.

Rhodanese activity was tested by the following procedure. Duplicate, 12-in. test-tubes containing: 0·5 ml., 0·125 *M* sodium thiosulphate; 0·5 ml., 0·125 *M* potassium cyanide; 0·5 ml., 0·2 *M* potassium dihydrogen phosphate; 1·0 ml. cell suspension (washed) were incubated at 30° C. for 15 min., the final *p*H of the mixture being 8·3. After incubation, the reaction was stopped by the addition of 0·5 ml. of 36 per cent formaldehyde. A blank tube was included in which the formaldehyde was added at the outset of the incubation period. The contents of the test-tubes were diluted with 25 ml. distilled water and centrifuged on a bench centrifuge to remove bacterial cells. 2·5 ml. ferric nitrate reagent were added to the clear supernatant, and the colours obtained were read at 470 mμ in a Unicam *S.P.* 600 spectrophotometer.

The following results were obtained:

Tube	Optical density at 470 mμ
Blank	0·01
I	0·750
II	0·735

These results seemed to indicate the presence of rhodanese. Boiled cells of *Th. thiocyanoxidans* were also incubated with thiosulphate, cyanide and potassium dihydrogen phosphate at *p*H 8·3, but there was no production of thiocyanate.

Another possibility was that thiocyanate might be formed from the chemical combination of cyanide and tetrathionate, the latter compound being a probable intermediate in thiosulphate oxidation by *Thiobacilli*.

To preclude this possibility the test for rhodanese was carried out under anaerobic conditions, in Thunberg tubes, which had been evacuated and filled with nitrogen. The results of this experiment indicated that the formation of thiocyanate from thiosulphate and cyanide does not involve the oxidation of thiosulphate to tetrathionate, but is a straightforward trans-sulphuration as required by the rhodanese reaction.

The production of thiocyanate with time is shown in Table 1.

Table 1. Thiocyanate Production when Washed Cells of *Th. thiocyanoxidans* are incubated with Cyanide and Thiosulphate

Time (min.)	Thiocyanate (μgm./ml.)
10	55
30	65
40	70
60	76
80	81
120	85

The effect of varying the concentration of cyanide was tested. Reaction tubes were set up containing a standard amount, namely, 0·5 ml. of 0·05 *M* thiosulphate; the cyanide concentration was varied, as was the potassium dihydrogen phosphate concentration, so that the optimum *p*H of 8·3 was maintained.

Tubes were incubated at 30° C. for 70 min. and the reaction stopped by the addition of 0·5 ml. of 36 per cent formaldehyde. The tubes were centrifuged and their contents assayed with ferric nitrate for thiocyanate. The results are given in Table 2.

Table 2. Effect of Varying the Cyanide Concentration on the Production of Thiocyanate by *Th. thiocyanoxidans* from Thiosulphate and Cyanide

Molarity of potassium cyanide	Thiocyanate formed (μgm./ml./70 min.)
0·25	55
0·125	35
0·0025	20
0·005	5

If the concentration of thiosulphate is taken as the limiting factor for the production of thiocyanate, these results show that the rhodanese system is not inhibited by an excess of cyanide. This is a significant point of difference between the pure crystalline rhodanese obtained by other workers[2] and the rhodanese present in *Th. thiocyanoxidans*.

These latter results must, however, be treated with caution as they involve a comparison between a pure crystalline enzyme and whole cells.

This work was carried out with the encouragement and under the supervision of Prof. F. C. Happold and was aided by a grant from the Gas Research Council.

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Localization of Oxidative Enzyme Systems in the Uterus and Vagina of the Rat

The evolution of histochemical methods for the localization of oxidative enzyme systems in tissues[1] has made it possible to study the effects of endogenous hormones on the intensity and distribution of such enzymes in reproductive organs. Enzyme systems concerned with succinate and lactate oxidation in the uterus and vagina of the rat have been previously shown to be markedly under the influence of changes in the normal endogenous hormonal balance in the female albino rat[2]. We have now followed the histochemical changes in the uterus and vagina of the rat through the œstrous cycle.

Albino rats, 100 days old, were studied by the vaginal smear technique through three consecutive œstrous cycles. During the fourth cycle, regularly cycling females were selected for study at the following stages: preprocestrus, procestrus, œstrus, metœstrus, 36-hr. dicestrus and 60-hr. dicestrus. The animals were killed by concussion and pieces of vagina and uterus were frozen immediately on 'dry ice', sectioned at 30μ and stained for succinate oxidation according to a procedure previously outlined (ref. 1, *b*). Staining as a result of lactate oxidation was carried out in a similar fashion with 4·0 ml. of 1·0 *M* sodium lactate substituted for succinate, 26 ml. of phosphate buffer with cyanide, and an addition of 4·0 ml. of lactate oxidation (1·0 mgm./ml.) in buffer. All tissues were studied by photographing the stained preparations under standardized conditions and comparing prints for intensity of staining.

Examination of vaginas at various stages of the œstrous cycle for lactate oxidation diaphorase showed that the most intense activity was displayed at periods characteristic of high œstrogen titre in the animal (preprocestrus, procestrus and œstrus); while during metœstrus and both stages of dicestrus vaginas displayed considerably lower degrees of enzymatic oxidation. In the former more active stages, the localizations of lactate oxidation were concentrated in areas of the vaginal epithelium known to be metabolically active at this time. The germinative and luminal layers of epithelium during preprocestrus and procestrus showed an intense reaction (Fig. 1,1). The cells of the lumen have been previously identified with high mucin production[3].

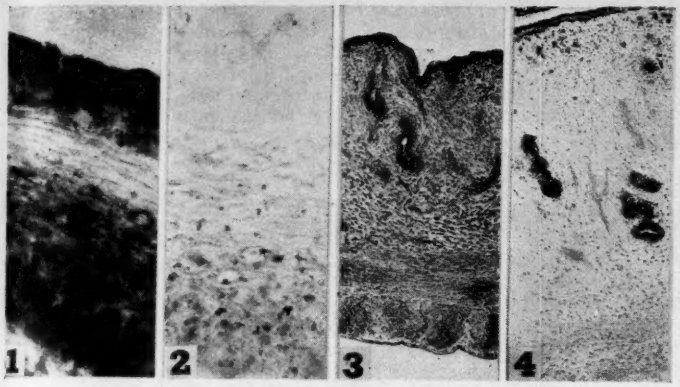

Fig. 1. 1, Lactate oxidation diaphorase in vaginal epithelium at proœstrus. Note high activity in luminal (upper) and germinative (lower) layers. Cornified cells (middle) show no activity. 2, Vaginal succinate oxidation activity at preproœstrus. Mucin-producing cells (upper) are inactive, whereas the germinative layer shows little staining. Cells undergoing cornification (middle) are losing much of the enzyme. 3, Proœstrus uterus containing high lactate oxidation activity in the luminal and glandular epithelium. Considerable staining also occurs in the stromal and muscular elements. 4, Late proœstrus or early œstrus uterus showing high succinate oxidation activity in epithelium and a low to negative reaction in the stroma. Muscle is lightly stained (lower right)

Consistent with current beliefs concerning the lowered metabolism or inactive state of cornified cells, our results demonstrated little or no enzymatic activity within such structures.

Oxidative enzymatic activity as a result of the succinate oxidation demonstrable with these methods was quite low in intensity. Although the highest activity was shown during œstrus and proœstrus, vaginas stained at these times had low activity in the germinative layers and no perceptible activity in cornified and mucified cells (Fig. 1,2). It should be noted that the apparent absence of succinate oxidation activity in cells producing mucin represents a feature quite distinct from that of lactate oxidation activity in similar cells. Mucin production as a result of exogenous œstradiol stimulation of the vagina has been shown to be associated with lactate oxidation diaphorase[4].

Uterine succinate oxidation and lactate oxidation was maximal during proœstrus when large quantities of fluid are found within the lumen of the uterus. Lactate oxidation activity was localized within the luminal and glandular epithelium, stromal cells and myometrium (Fig. 1,3). The greatest activity was associated with epithelial structures and this is probably a reflexion of increased oxidative metabolism of these structures requisite for synthetic and secretory activity[5]. Stromal connective tissue cells showed moderate to high staining within the cytoplasm, while the nuclear constituents were apparently unreactive. Muscle stained moderately throughout. The high activity of epithelial structures decreased considerably during metœstrus and continued to drop even further at diœstrus. Generally, both stromal elements and muscle showed a considerable reduction in enzymatic activity at these stages.

Succinate oxidation appeared to be very low or absent from the uterine stromal cells throughout all stages of the œstrous cycle. A drop in succinate oxidation activity was evident at late proœstrus or early œstrus, and was most pronounced in the myometrium, with a lesser loss evident in the epithelium (Fig. 1,4). With the onset of diœstrus and throughout this stage, both muscle and epithelium contained a low level of succinate oxidation.

It is believed that the above changes in succinate and lactate oxidation offer further evidence that these enzyme systems are under the influence of the changing hormonal environment within the animal. In addition, these results suggest that different structures or tissues within the same organ respond individualistically to presumably the same hormonal balance, thereby indicating that adequate histochemical localization of a given enzyme should be included with quantitative data such as that derived from homogenate studies. Enzyme distribution in the vaginal epithelium indicates clearly the type of error that can be introduced in homogenate studies if the mass of the tissue is not also considered in terms of highly active areas of oxidation coexistent with totally inactive (keratinized) regions within the same organ (Fig. 1, 1 and 2).

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Variation with Age of Shrinkage Temperature of Human Collagen

DURING the course of an investigation of hydrothermal shrinkage temperatures of human tissue, we examined many samples of different ages. Small fibres were teased out from the tissue immersed in 0·9 per cent sodium chloride solution and transferred with salt solution to a capillary tube. This was placed in a micro-melting point apparatus (Gallenkamp) and the shrinkage temperature determined by viewing under low magnification. The voltage across the heating element was controlled by a rheostat to give a rise of not more than 2 deg. per min. The temperatures at which the fibres started and finished shrinking were designated Ts_1 and Ts_2 respectively. Samples were taken from dura mater or fascia lata at autopsy or at operation from cases not suffering from 'connective tissue' disease and were examined without delay. In saline, fibres from either tissue from any one individual shrunk over the same range, and there was no difference between different fibres from one tissue. Results are given in Table 1.

Statistical analysis shows that for Ts_1 the variation ratio (F) between the groups is 35·3, which is highly

Table 1. Variation of Shrink Temperature with Age

Age group	Ts_1 (° C.)		Ts_2 (° C.)		No. of cases
	Mean	Range	Mean	Range	
Fœtuses 12–40 weeks	54·4	53–55	60	59–62	7
0–14 years	57·7	55–59	63·9	61–67	12
15–25	59·8	57–62	65·7	64–68	7
26–44	59·1	57–61	66·2	65–67	8
45–88	61·2	59–63	67	66–68	18

significant. The standard error for Ts_1 (single determination) is 1·33 and the least significant difference between the groups is 1·43 ($P = 0·05$) for means of seven determinations in each group and correspondingly less where the number in a group is greater than seven. It is seen that, except between the age-groups 15–25 and 26–44 years, the difference of the means between groups is greater than 1·43, and we therefore conclude that in any two age-groups, with the exception of those mentioned above, the Ts_1 is significantly higher in the older group. The Ts_2 figures clearly follow the same pattern and the same conclusions apply here.

A similar investigation was carried out with collagen fibres of human uteri and the results are given in Table 2. Here the tissues are divided into only two groups, 45 years being chosen as the approximate age of menopause. Except for one case aged 4 months, the younger group ranged from 25 to 45 years of age and four of these were pregnant; the range of the older group was 49–78 years. Within each group there appeared to be little variation of Ts_1, and statistical analyses showed that the Ts_1 means differed in a highly significant way between the two groups ($F = 14·41$; standard error of $Ts_1 = 1·74$; least significant difference of the means between the groups = 1·37 for $P = 0·05$). Ts_2 did not vary significantly between the two groups. By comparison with results in Table 1, collagen from the uterus up to about the age of menopause is seen to be closely similar, as regards hydrothermal stability, to fœtal collagen. Uterine collagen in the older group, on the other hand, resembled the 0–14 year collagen.

Table 2. Shrink Temperature of Human Uteri

Age (years)	Ts_1 (° C.)		Ts_2 (° C.)		No. of cases
	Mean	Range	Mean	Range	
Under 45	55·2	53–57	63·4	61–67	12
Over 45	57·8	55–61	63·1	61–67	16

Few studies of shrinkage temperature and age have been carried out on human tissue; but recently Hall and Reed[1] found that, in water, there was no difference with age in a group of twelve people whose ages ranged from 7 to 89 years. With one exception the range of shrinkage was 62–69·5°, which is somewhat higher than our range of 55–68° covering similar ages. This confirms our observation that shrinkage temperatures are higher in water than in saline, and it might be that, in water, any shrink temperature variation with age would not be evident.

The results reported here add further to the evidence, already accumulated from investigations of other properties[2–6], which demonstrate that collagen becomes more stable with age in the organism. Fœtal collagen is of special interest. Its consistently low shrinkage temperature, whatever the stage of development, suggests that there is a certain minimum degree of stability of collagen once it is laid down as a fibre, and that there is little change in this stability during fœtal life. It would appear from our results that, with growth and development, the collagen becomes further stabilized from birth until adolescence. There is no further stabilization until after middle age, when the subsequent shrinkage temperature rise may be a manifestation of the ageing process.

Harkness and Harkness[7] have shown that the uterus is exceptional in its property of rapid formation and rapid absorption of collagen during and after pregnancy, and in this property of more rapid metabolism it resembles collagen in young growing tissue[6]. The low shrinkage temperatures of uterine collagen would also suggest that it is a less mature form than collagen from elsewhere in the adult, though it is somewhat more stable after the menopause.

This work forms part of an investigation of the shrinkage temperatures of normal and abnormal human collagen, which it is intended to publish in full shortly.

We thank Miss B. M. Haines for introducing us to the micromethod of measuring shrinkage temperatures.

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Role of Phage Antibodies in the Development of Non-toxigenic Cultures of *Corynebacterium diphtheriae*

That the toxigenicity of diphtheria cultures is associated with the lysogenic state is well established. It now seems that the loss of ability to produce toxin may be mediated by the action of antiphage serum upon lysogenic cultures.

In guinea pigs given intracutaneous injections of virulent cultures of *C. diphtheriae*, and protected against death by the intraperitoneal administration of antitoxin some hours later, a low-grade infection may persist for several weeks. During the latter part of this period non-toxigenic, non-lysogenic cultures may be isolated from the lesions. At this time, also, the presence of phage-neutralizing antibodies in the animals' blood can be demonstrated.

Moreover, if antiphage serum is produced in rabbits by injection of filtered lysates of toxigenic diphtheria cultures, and a toxigenic culture is grown in broth fortified with this, after some ninety daily passages in the presence of these antibodies the culture is found to have become non-lysogenic and avirulent.

The avirulent cultures obtained either by the *in vivo* or the *in vitro* methods regain their virulence upon lysogenization with phage.

It is well known that in other lysogenic species there is concomitantly (*a*) spontaneous induction of some cells resulting in subsequent lysis and liberation of phage, and (*b*) more or less frequent failure in transmission of prophage during cell division, so that non-lysogenic cells arise. Normally the latter are either lysed or lysogenized by the infectious phage present in the environment, so that a state of equilibrium is reached. It is known, also, that the addition of citrate or oxalate to the culture medium can prevent re-infection, and that by this method, after many transfers, cultures free of phage can be obtained. The findings outlined above suggest that antibodies to phage, by binding free virus, may bring about the same result.

It should be recalled that Jungeblut[1] found thirty years ago that six passages of virulent cultures in broth containing antitoxin brought about a loss of ability to produce toxin; but his evidence suggested that this was a transient phenomenon. Some of our converted cultures have remained non-toxigenic during ten passages over a six-month period.

The work reported here offers support for the hypothesis that antiphage bodies are important in conversion, and may account for the occurrence of the avirulent cultures isolated from throats and from the lesions of the chronic cutaneous diphtheria cases found in some parts of the world.

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Protein Degradation of Fœtal and Cancer Tissues in the Presence of Ethionine

INTRACELLULAR proteolytic enzymes are present in many tissues and they hydrolyse proteins during autolysis. Some experimental data support the idea of a physiological action of these enzymes: the augmentation of catheptic activity during the regression of cancer[1], and of larval tails of *Xenopus*[2]. But it has been shown that intracellular protein degradation is dependent on energy[3], and that *o*-fluorophenylalanine, a well-known anti-amino-acid, inhibits protein catabolism[4,5]. Steinberg *et al.*[5] also showed that this compound does not influence catheptic proteolysis. These observations lead to the supposition of a mechanism of protein degradation different from that of the simple catheptic hydrolysis. Similar conclusions are reported by Yakovlev[6], who studied the action of phosphate, dinitrophenol and other substances on proteolysis of tissues. He reported also that fœtal tissues behave against dinitrophenol differently from the normal rat tissues.

I have investigated the action of another anti-amino-acid, ethionine, upon the intracellular protein degradation of normal and fœtal liver and of benzopyrene sarcoma. In all cases 400-mgm. aliquots of 0·5-mm. tissue slices are incubated for 3 hr. at 37° in 4 ml. phosphate buffer *M*/15 at *p*H 7·2 containing ethionine 2×10^{-3} *M*. At zero time, and at the end of the incubation, the slices are homogenized in their medium and proteins are precipitated with an equal amount of 14 per cent trichloracetic acid. On the supernatant the ninhydrin-positive substances are determined colorimetrically[7]. Table 1 gives the values of the amino-acids released in control experiments and those carried in the presence of ethionine.

Table 1. INHIBITION OF PROTEIN BREAKDOWN IN NORMAL AND FŒTAL RAT LIVER AND OF BENZOPYRENE SARCOMA

	mgm. released amino-acids/100 gm. fresh weight		
	Controls		Ethionine
	Zero time	3 hr.	3 hr.
Normal liver	108 ± 11	210 ± 18	117 ± 13
Fœtal liver	122 ± 13	180 ± 17	130 ± 13
Sarcoma	150 ± 14	270 ± 22	244 ± 21

The control experiments show decreased degradation of fœtal proteins, and increased degradation in sarcoma. In the presence of ethionine, degradation in sarcoma is slightly inhibited by the anti-amino-acid (only 20 per cent), where in both normal and fœtal livers ethionine inhibits about 90 per cent of the normal protein degradation. This difference is probably due to a different concentration of the proteolytic enzymes susceptible to anti-amino-acid in the tissues examined. It is also important to note that ethionine inhibition of protein degradation in fœtal liver is quantitatively the same as that observed in normal liver. This result is in contrast with the observations reported by Yakovlev[6] on the negative effect of dinitrophenol on fœtal liver autolysis. But it must be remembered that Yakovlev studied the autolysis of homogenates, whereas in the present case intracellular degradation is observed in tissue slices: this difference in the experimental conditions may explain the observed variations in Yakovlev's and my results.

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Presence of Œstrone, Œstradiol and Œstriol in Extracts of Ovaries of Laying Hens

GUSTAVSON[1] found a high œstrogenic activity in excreta of laying hens. Others[2] have found activity in ovaries and greater activity in maturing follicles. Hurst[3] has found œstriol and œstrone in excrement of hens, and œstriol, œstrone and œstradiol in that of roosters. The present communication describes the identification of œstrone, œstradiol and œstriol in ovarian tissue of the fowl and the results of a search for their presence in blood.

Ovaries were removed from laying white Leghorn hens. Follicles larger than about 5 mm. diamete. were slit open, and yolk material was discarded, Ovaries with follicle walls attached were weighedr immersed in methanol, and disintegrated with a Waring blendor.

Œstrogens were extracted as described by Mitchell and Davies[4] for human placenta. Residues from

final extractions were taken up in a small volume of warm 90 per cent ethanol and stored for 18 hr. at −10° C. The supernatant was concentrated and chromatographed. Preliminary fractionation into œstriol and œstrone–œstradiol fractions was omitted.

Chromatography was performed on Whatman No. 1 filter paper and an absolute methanol – petroleum ether system at 34° ± 1° C. was used[5]. Good separation of reference œstriol, œstradiol and œstrone was obtained with a 6–10 hr. run, provided that strips were dried in an oven immediately before application of the steroids, and were then immediately placed in the chromatography chamber for equilibration.

Narrow strips cut from the developed chromatograms were immersed in freshly prepared diazotized sulphanilic acid and then in 1·1 per cent sodium carbonate. The yellow spots formed indicated the positions of the œstrogens. The steroids were eluted into ethanol, and the ultra-violet absorption spectra were examined on a recording spectrophotometer. Identifications of œstrone and of œstradiol were confirmed by 'finger-printing' with reference steroids labelled with carbon-14 (Chas. Frosst and Co., Montreal). The steroid labelled with carbon-14 was added to a sample of the presumptive œstrogen isolated from ovarian tissue in the estimated ratio 5 : 1 (carrier to labelled steroid). The amount of labelled material used was 5γ, which gave a barely perceptible stain with diazotized sulphanilic acid reagent. The mixture of labelled and presumptive steroid was chromatographed and the strip was stained and then exposed for three days on X-ray film. Complete coincidence of stained spots with spots on the radioautograph in respect of shape and position was taken as positive identification of presumptive œstrogen with labelled steroid. Three spots, positive to diazotized sulphanilic acid and to Kober reagent, were located on chromatograms of extracts of 'free' œstrogen fractions obtained from ovarian tissue. Mobilities were similar to those of œstriol, œstradiol and œstrone on reference chromatograms, and their ultra-violet absorption spectra agreed with those of the appropriate reference œstrogens. Results of the radioactive 'finger-printing' of the presumptive œstrone and œstradiol are shown in Fig. 1. Chromatograms of the 'conjugated' and 'protein-bound' fractions of ovarian extracts contained small amounts of material positive to diazotized sulphanilic acid, but individual œstrogens were not found in these fractions.

A ketosteroid described previously[6] was found in all extracts of ovaries and of blood from laying hens.

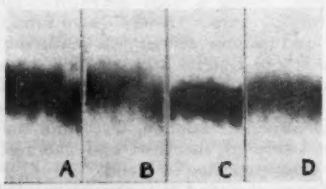

Fig. 1. Radioautographic 'finger-printing' of presumptive œstrogens from avian ovarian tissue.
(*A*) Spot on radioautogram of chromatogram of presumptive œstrone mixed with 5γ of œstrone labelled with carbon-14.
(*B*) Spot on same chromatogram stained with diazotized sulphanilic acid.
(*C*) Spot on radioautogram of chromatogram of presumptive œstradiol mixed with 3γ of 17-β-œstradiol labelled with carbon-14.
(*D*) Spot on same chromatogram stained with diazotized sulphanilic acid

The results of bioassays conducted on eluates of the ketosteroid indicated no œstrogenic activity. Neither œstradiol nor œstriol was located in any of the fractions of an extract from 650 ml. of blood from laying hens. A compound either identical with, or very similar to, œstrone was located in the 'conjugated' fraction of the extract. A ketosteroid described previously[6] was found both in 'free' and 'conjugated' blood fractions. This material was recovered by dialysis[6] from 50-ml. samples of blood from laying hens, but it was not found on chromatograms of similar extracts of 50 ml. blood from male or immature female fowl.

The results provide evidence, based on chromatographic mobility, ultra-violet spectrophotometry and chemical reaction, that the main œstrogens elaborated by the avian ovary are œstrone, œstradiol and œstriol. The identity of the presumptive œstrone and œstradiol with the reference compounds labelled with carbon-14 was established by the radioautographic 'finger-printing'. The identity of the chromatographic mobility of the presumptive œstriol with that of the reference sample, coupled with its ultra-violet absorption spectrum and positive Kober reaction, constitute strong evidence that the material isolated from avian ovaries was œstriol.

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Effect of Thiosemicarbazones on the Multiplication of Tobacco Mosaic Virus

While much effort has been expended on the chemotherapy of plant virus diseases[1], it seems to provide no conclusive evidence. Iwasaki *et al.*[2] obtained marked inhibition of influenza and Newcastle virus by thiosemicarbazones and related compounds. We have performed tests to determine the effect of certain of the thiosemicarbazone derivatives on the multiplication of tobacco mosaic virus in detached tobacco leaf tissues.

The strain of virus used was the ordinary strain found in Japan. Unsubstituted thiosemicarbazones from benzaldehyde, acetophenone, cinnamaldehyde, and benzalacetone and some of the para-substituents (nitro-, dimethylamino-, amino- and acetylamino-) of them were tested. The derivatives employed were obtained through the kindness of Dr. Tamio Nishimura of the Kitasato Institute, Tokyo. All

Table 1. INHIBITION OF MULTIPLICATION OF TOBACCO MOSAIC VIRUS BY THIOSEMICARBAZONES

Thiosemicarbazone derivatives	Para-substituents	Concentration of chemicals (μgm./ml.)	Percentage of increase (+) decrease (−) in virus multiplication	
Benzaldehyde	unsubstituted	50	+ 5*	−22†
,,	dimethylamino	25	−	+ 5
,,	acetylamino	25	−	−10
Cinnamaldehyde	unsubstituted	25	+14	−14
,,	dimethylamino	25	−	+ 6
,,	acetylamino	25	−	−12
Acetophenone	unsubstituted	50	−	−35
,,	acetylamino	25	−	− 4
Benzalacetone	unsubstituted	50	−20	−24
,,	nitro	50	− 5	−
,,	amino	50	− 5	− 9
,,	dimethylamino	50	−15	+ 6
,,	acetylamino	10	−19	+ 1

* Analysed by ammonium sulphate method; † by trichloracetic acid method. Figures represent the average values of 2–3 independently treated samples.

the compounds were dissolved in a small amount of acetone and were filled up to a desired volume with distilled water. Each compound was used at a concentration of 10–50 μgm./ml. The detached tobacco (*Nicotiana tabacum*, Turkish) leaves were inoculated by rubbing with a gauze pad soaked in tobacco juice infected with mosaic virus and were maintained in an incubator for 24 hr. at 25° suspended on water. Then the leaf-halves or leaf disks (12 mm. diam.) cut from the inoculated leaf were floated in continuous light (daylight fluorescent lamps) on aqueous solutions of the test compounds; the opposite leaf-halves or other disks floating on water served as controls.

After 6 days incubation, the leaf tissues were homogenized and analysed for the virus. Two analytical methods were tried. One consisted of precipitating virus protein by ammonium sulphate and then determining the relative concentration of the resultant precipitates by a colorimetric procedure using the Folin reagent[3]. The other method, in which usually 20 leaf disks (0·5–0·6 gm.) were used, was the combination, according to Bancroft and Curtis[4], of the chloroform–water emulsion technique and the trichloracetic acid method for precipitating and hydrolysing tobacco mosaic virus. In the latter case, the virus was assayed by spectrophotometric methods of measurement at 260 mμ.

Thiosemicarbazones, with or without para-substituents, were tested at first (Table 1). The compound most effective in producing inhibition was benzalacetone thiosemicarbazone both in the analysis by the ammonium sulphate method and by the trichloracetic acid method. Furthermore, in this case, the unsubstituted compound was most effective, indicating that introduction of a nitro-, amino-, dimethylamino-, or acetylamino-group at the para-position of the benzene nucleus diminishes the inhibitory activity. Among the para-substituents of benzalacetone thiosemicarbazone, however, it seemed likely that dimethylamino and acetylamino substituents exhibit a considerable inhibition by the analysis of the ammonium sulphate method, but not by that of the trichloracetic acid method. Accordingly, both dimethylamino- and acetylamino-para-substituents of benzaldehyde and cinnamaldehyde thiosemicarbazones were tested and were compared with the unsubstituted ones. From these results it is evident that these compounds do not show any detectable increase in inhibitory activity when analysed by the trichloracetic acid method. Although acetophenone thiosemicarbazone inhibited markedly, according to the trichloracetic acid method, the multiplication of the virus, it produced comparatively severe toxicity to host leaf, and these observations cannot be accepted without question. Iwasaki *et al.*[2] have reported that unsubstituted benzalacetone thiosemicarbazone is most effective against influenza viruses, *PR*8, *FM*1 and Lee strains, and Newcastle disease virus. In this respect, these results are well in accord with those obtained with the plant virus.

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Sensitivity of the Spermatogenic Process in the Rat to Radiomimetic Drugs and X-Rays

SPERMATOGONIA are considered to be the most radiosensitive cells of the male germinal epithelium. They may be selectively damaged or destroyed without apparently impairing the continued development into spermatozoa of later generations of spermatogenic cells present at the time of irradiation. In the mouse, Oakberg[1] has found that exposure to 200 r. rapidly destroyed all type *B* spermatogonia, and Bateman[2] observed a transient sterility in male mice six weeks after exposure to this dose which was associated with marked oligospermia. These two findings are correlated and provide an estimate of the overall time required for the development of spermatozoa in the seminiferous tubules (testicular phase) and their transport through the epididymis (epididymal phase). Other results from radioactive tracer experiments in the mouse[3] have also indicated a period of about 40 days for the same process. Since Oakberg[4] has proposed that five weeks (34·5 days) are required for the testicular phase of spermatogenesis in the mouse, it follows that an additional week is occupied by the epididymal phase.

In rats after 200 r. (whole-body irradiation) the only significant change we have observed during nine weeks of consecutive weekly matings was a reduction in average litter size during the fourth and fifth weeks (Fig. 1). There was no noticeable oligospermia. After 500 r. given either as a single dose or five daily exposures of 100 r., rats did not become sterile until the seventh week, although the average litter size dwindled progressively in previous weeks (Fig. 2). The onset of sterility was accompanied by pronounced oligospermia, and the sterile state persisted for at least three months. In the mouse, it is well known that prolonged sterility after 500 r. commences in the fourth week; according to Auerbach[5], this is due to the destruction of spermatocytes as well as spermatogonia. These comparative results suggest the following conclusions: (*a*) the radiosensitivity of corresponding cells in the mouse and rat are markedly different, and/or, (*b*) the overall

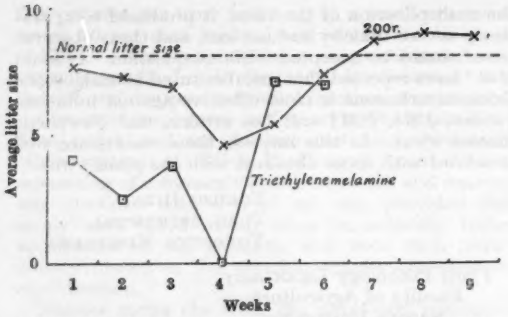

Fig. 1. Effect on male rat fertility of a single dose of triethylenemelamine (0·2 mgm./kgm., intraperitoneal) compared with one dose of X-irradiation (200 r., whole-body)

time for spermatozoa to develop in the testis and appear at insemination is considerably longer in the rat than the mouse.

If the radiosensitivity of cell types is comparable in the two species, then sterility in the fourth week in the mouse corresponds to the seventh week in the rat. On the other hand, recent publications suggest that the duration of the testicular phase in mouse and rat are similar; this will relate differences in the total time to that required for the passage of sperm through the epididymis. From a study of the progression of injected radio-opaque material through the rat epididymis, MacMillan and Harrison[6] have suggested that the duration of this phase is 12–16 days.

We also made detailed examinations of the effects of radiomimetic drugs (and related compounds) on the fertility of male rats. It is our experience that these substances can produce well-defined periods of sterility which are indicative of selective actions on various stages of spermatogenesis[7]. For example, for triethylenemelamine the most susceptible phase corresponds to a period of sterility in the fourth week after a dose (Fig. 1). This finding was previously correlated with drug action on spermatogonia[7], but no allowance was made for the epididymal phase. Infertility in the fourth week after giving triethylenemelamine now appears to be the result of interference with a later stage of spermatogenesis. The ability of a short course of this drug to produce a sterile period lasting for several weeks from treatment, followed by rapid recovery six weeks later, contrasts with the onset of prolonged sterility in the seventh week after 500 r. (Fig. 2). It is tempting to infer a

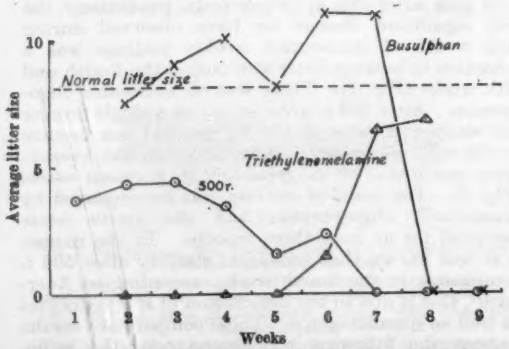

Fig. 2. Comparison of the effects on male rat fertility of triethylenemelamine (five daily doses, 0·2 mgm./kgm., intraperitoneal), X-irradiation (500 r., whole-body) and busulphan (one dose, 10 mgm./kgm., intraperitoneal)

significant correlation between the time relationships of these effects.

We have also found that busulphan (myleran) has a well-defined action on rat fertility. This radiomimetic drug, unlike triethylenemelamine and radiation (500 r.), had no effect on size of litter until the eighth week after a single dose (Fig. 2), when sterility developed with remarkable rapidity. This change was also associated with the onset of oligospermia (as with 500 r.) and is consistent with the destruction of early germinal cells. Since the rats were fully fertile 45 days after the dose but sterile a week or so later, it may be that the overall time for sperm development and their appearance at copulation is even longer than has been supposed.

Comparable experiments in the mouse are in progress, and also histological studies in both species.

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Isolation of the Lethal Factor of Diphtheria Toxin by Electrophoresis in Starch Gel

Highly purified toxins of *Corynebacterium diphtheriae* have been shown to be very complex mixtures by antigen–antibody diffusion in gelatin[1]. In spite of their apparent homogeneity as determined by filter paper electrophoresis, one of us demonstrated the complex nature of such toxins by electrophoresis and immunoelectrophoresis in starch gel[2]. All the crude, as well as the crystalline, toxins (a generous gift of Dr. C. G. Pope) screened by these methods (Poulik, in preparation), have invariably shown the presence of two major components in addition to many minor ones. Since diphtheria toxin is lethal in very high dilutions for guinea pigs, it was assumed that it is most probably one of the two major components which is the cause of death.

Diphtheria toxin *TD*-3-51 (kindly given by Dr. Inge Scheibel, Statens Serum Institute of Denmark), was produced on a tryptic digest of beef muscle medium[3,4] and contained 162Lf./mgm. (0·084 mgm. total N/mgm.; 0·069 P–N/mgm.). This material was subjected to starch gel electrophoresis[5] in a discontinuous system of buffers (*tris*-citrate in the starch gel and sodium hydroxide/boric acid in the electrode vessels[6]). This combination of buffers resolved the two major components very well and thus assured their purity.

Fig. 1 shows diagrammatically the result obtained. After electrophoresis the gel was cut into blocks 1 cm. wide and the proteinous materials contained in these blocks were removed by squeezing the sponge-like starch blocks after freezing and thawing. The

Fig. 1. Starch gel electrophoresis in discontinuous system of buffers, at 6 V./cm. for 5 hr. Material: Toxin-*TD*-3-51, 162*Lf.*/mgm., 0·084 mgm. total N, 0·069 P–N/mgm.

toxicity of these solutions was tested on guinea pigs (250–300 gm.) by injecting 0·1 ml. intradermally. The material obtained from section 7 killed the animal in 1 : 1,000 dilution in four days or sooner and produced a typical skin reaction at dilution 1 : 100,000. The solution from section 5 killed the animal only when injected undiluted and produced a typical skin reaction at a dilution of 1 : 1,000. Autopsies performed on animals killed by the materials in sections 7 and 5 revealed pathological findings typical for diphtheria (hæmorrhage into adrenals; pleural effusion; congestion of the wall of the gut). Toxin recovered from section 5 produced a much larger area of necrosis at the site of injection. This activity and the slower rate of migration are the only criteria, at the present time, which make us feel that this is a different substance as compared with material in section 7. It has not yet been possible to obtain a conclusive demonstration that this component is a separate immunological entity.

It was concluded that the most potent lethal factor of the toxin of *Corynebacterium diphtheriae* was isolated in section 7. This component is not a single protein since starch gel immunoelectrophoresis[3] had demonstrated at least two and possibly four lines of flocculation in this area, two of them intersecting and thus further indicating the complexity of this fraction. Material from section 5 was also found to be heterogeneous. It was also shown experimentally that more than one lethal factor is present in the toxins grown in culture media, and that each of these is again a mixture of proteins, presumably with different enzymatic activities, such as hæmolysin, deoxyribonuclease[7], transferrin-splitting factor (Poulik, unpublished work), a possible mucopolysaccharidase[3], hyaluronidase and a necrotizing factor[8], to mention just a few. Since any of these enzymes, and possibly others, may be present in either of the electrophoretic components described, speculation on the mode of action of diphtheria toxin is not justified until all the biologically active factors present are determined.

The opinion of O'Meara[9] and that of Niggemeyer[8], that the diverse clinical courses of the disease could be explained on the basis that several such factors are in operation either singly or in combination, is shared by us. Recent experiments described by Yoneda and Pappenheimer[10] on the production of extracellular products released by certain non-toxigenic strains of *C. diphtheriae* and a toxigenic strain derived from them by infection with a bacteriophage, showed the way of approach to such a problem. Since clinical cases exist (hypertoxic diphtheria) where administration of commercial antitoxins fails to control the course of the disease[6,9], the question remains what antigen or antigens should be used for preparation of antisera which would be able to cope adequately with all the toxic materials regardless of their type or quantity.

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Mode of Action of Organophosphorus Insecticides

It is widely held that organic phosphates exert their insecticidal action by the inhibition of cholinesterase activity in the nervous system. Definite proof of this theory, however, has never been furnished and some years ago doubt as to its correctness was expressed by Hopf[1] and also by Lord and Potter[2].

According to many investigators, there is an excess amount of cholinesterase in the nervous system of mammals, and toxic effects will only be seen after more than 80 per cent inhibition of enzymic activity. The occurrence in such an excess is quite a normal feature of enzymes. Assuming that the cholinesterase present in insects is essential for some vital function of the organism, possibly for conduction in the nervous system, one might expect poisoning symptoms to occur only when the cholinesterase activity is strongly inhibited. It should not be overlooked that, in order to prove that a substance derives its toxicity from the inhibition of some enzyme, it is necessary to show, (1) that it has a strong inhibitory action on the enzyme *in vitro*, and (2) that this enzyme in the living insect is actually inhibited at the time that symptoms of intoxication appear.

Our investigations were carried out largely with O,O-dimethyl-O-2,2-dichlorovinyl phosphate, which is very toxic to houseflies (*Musca domestica*; $LD50 < 0{\cdot}1$ μgm./gm.). The inhibitory action of this substance on housefly cholinesterase *in vitro* is about a hundred times that on horse-serum or mouse-brain cholinesterase and twice that of paraoxon on housefly cholinesterase. At a rough estimate, only 0·5–1·5 mol. of O,O-dimethyl-O-2,2-dichlorovinyl phosphate per mol. (active group) of enzyme is required to give 50 per cent inhibition. It is clear, therefore, that inhibition of cholinesterase could be the reason for its toxicity. However, it is also a very potent inhibitor of other esterases, especially in the housefly. One of these ali-esterases, present mainly in the thorax and clearly distinct from the cholinesterase which is chiefly found in the head, was able to split methyl butyrate at considerable speed *in vitro* and proved to be inhibited by approximately the same concentrations of O,O-dimethyl-O-2,2-dichlorovinyl phosphate as the cholinesterase; so its toxicity could also be due to inhibition of this ali-esterase. It was of interest, therefore, to investigate the inhibition, *in*

vivo, of both enzymes at the time intoxication appeared.

Inhibition of cholinesterase *in vivo* was measured in the following way. Houseflies were exposed to O,O-dimethyl-O-2,2-dichlorovinyl phosphate vapour. Poisoning symptoms such as hyper-excitation and convulsions occurred after some time and eventually the flies were knocked down. A simple device enabled us to remove each individual fly from the experimental glass as soon as this stage of intoxication was reached. The flies were then, until further treatment, kept in a test-tube chilled by a mixture of ether and solid carbon dioxide. When all the flies had been collected they were quickly transferred to a flask containing bicarbonate-saline and acetylcholine (acetylcholine $1{\cdot}5 \times 10^{-3}$ *M*) and homogenized. The suspension obtained was immediately used for measurement of cholinesterase activity in the Warburg apparatus—at 37° C. and *p*H 7·4 (bicarbonate–carbon dioxide buffer), without any further addition of acetylcholine—and compared with a control suspension of untreated flies. It contained about 3×10^{-9} *M* O,O-dimethyl-O-2,2-dichlorovinyl phosphate, which in other experiments was found to cause more than 90 per cent inhibition after 1·5 hr. of incubation without protection by acetylcholine. The addition of acetylcholine to the saline in which the flies were homogenized was necessary to prevent any O,O-dimethyl-O-2,2-dichlorovinyl phosphate present in the tissues but not yet irreversibly bound to the enzyme surface, from attacking the enzyme; especially since we have shown (Fig. 1) that O,O-dimethyl-O-2,2-dichlorovinyl phosphate readily reacts with the cholinesterase, forming an inactive complex and thus producing inhibition. After addition of acetylcholine, however, no further increase of inhibition occurs, the enzyme being then completely protected by the substrate molecules. This was confirmed by several experiments in which rather high concentrations of O,O-dimethyl-O-2,2-dichlorovinyl phosphate were prevented from exerting inhibitory effects by the presence of acetylcholine in a concentration normally used in our experiments. As a consequence of the method used, the enzymatic reaction started about 25 min. before measurement in the Warburg-apparatus could be undertaken. We therefore investigated the possibility of reactivation of the enzyme, especially as Aldridge and Davison[3] have shown that the inhibition of cholinesterase from rabbit erythrocytes by dimethylphosphates is slowly reversible. We found that there was no reactivation at all in the case of housefly cholinesterase, although it did in fact occur in the case of mouse-brain cholinesterase.

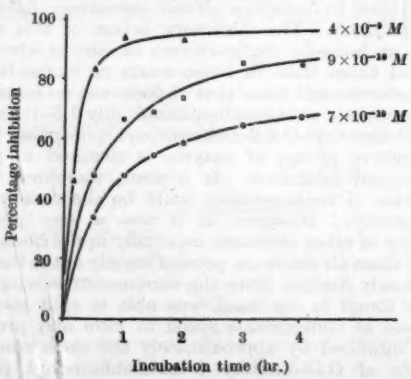

Fig. 1. Inhibition of housefly cholinesterase by O,O-dimethyl-O-2,2-dichlorovinyl phosphate. Incubation time is time available for the reaction between enzyme and inhibitor before the substrate is added

Measurements of *in vivo* inhibition as described above will, in our view, give a very good approximation to the actual inhibition value at the time of knockdown. Essentially the same method has been adopted for the measurement of inhibition of ali-esterase *in vivo*, using methyl butyrate as a substrate. Methyl butyrate, as was shown in several experiments, gives appropriate protection of the ali-esterase against O,O-dimethyl-O-2,2-dichlorovinyl phosphate under conditions such as those of our experiments on *in vivo* inhibition. In a few cases inhibition of cholinesterase has also been measured in heads or thoraces + abdomens, separated just before homogenizing took place. The results of our experiments are shown in Table 1.

Table 1. Percentage Enzyme Inhibition at the Time of Knock-down

ChE of whole flies	25, 27, 28, 24, 29, 29 per cent	mean 27 per cent
ChE of the heads	10, 39, 22 per cent	mean 24 per cent
ChE of thor.+abd.	43, 49 per cent	mean 46 per cent
AliE of whole flies	86, 84, 79 per cent	mean 83 per cent

These results are very striking. Although the overall values for inhibition are low, it cannot be excluded that stronger inhibition of cholinesterase activity was occurring at some small but essential part of the nervous system; but we nevertheless consider that the results in Table 1 provide evidence against an essential role of cholinesterase inhibition in the insecticidal action of O,O-dimethyl-O-2,2-dichlorovinyl phosphate. We do not claim that this evidence is conclusive, because it is possible that the results in the literature concerning the excess of cholinesterase present in the organism are incorrect. All the latter results are based on inhibition values *in vivo* which, so far as we know, were obtained without protection of the enzyme against excess of inhibitor and, therefore, are probably too high.

Our findings were provisionally confirmed by experiments on cholinesterase inhibition, in which di-*iso*propylfluorophosphonate, parathion and paraoxon were applied. The strong *in vivo* inhibition of the ali-esterase (splitting methyl butyrate) points to this enzyme and the possible role of its inhibition in the intoxication caused by organophosphates.

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Distinction between *Cardium edule* L. and *Cardium lamarcki* Reeve

From material gathered by the Danish Institute for Fishery and Marine Research in Danish estuaries I have examined the species of *Cardium* of which there were three types—*A*, *B* and *C*. Type *C* was identified as *C. exiguum*. In the literature the types *A* and *B* are described as varieties of *C. edule*. In my material the two types existed together in some of the estuaries, and they were often found in the same bottom samples, and always without any intermediate types. I have identified type *A* as *C. edule* L. and type *B* as *C. lamarcki* Reeve 1845 [1].

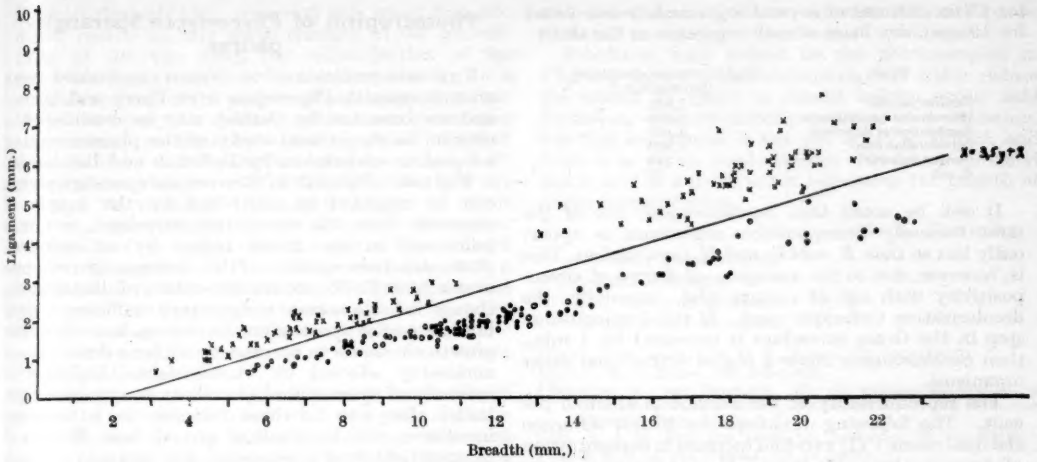

Fig. 1. ×, *Cardium edule*; ○, *Cardium lamarcki*

C. edule and *C. lamarcki* have the following distinctive characters: The ribs on the middle part of the shell of *C. edule* are flat and provided with small scales some distance from each other; in *C. lamarcki* these ribs are sharp and provided with small triangular closely placed scales, formed from the epidermis. The ribs on the posterior part of the shell are fairly well developed in *C. edule* and scarcely developed at all in *C. lamarcki*. Because of this difference the part of the shells around the siphons will close along a wavy line in *C. edule* and along an almost straight line in *C. lamarcki*. The epidermis is very badly developed in *C. edule*. The epidermis of *C. lamarcki* is rather thick and covers about 75 per cent of the surface of the shell. In colour and shape a difference between the two types also exists, *C. edule* being the more whitish and circular one, but as colour and shape vary much, these are not taxonomic characters.

C. lamarcki shows considerable variation, and smaller individuals from the vegetation and brackish water have thin brown shells with flat ribs without scales and broad furrows. This form somewhat resembles *C. exiguum*. At a length of 4–8 mm. they often suddenly change and begin to build the shell with narrow furrows, and sharp ribs with scales. This change in structure may be correlated with a change in habitat, for example, from vegetation to the bottom. *C. lamarcki* is very often found in the vegetation climbing by means of its byssus. I have never seen *C. edule* climbing in the vegetation or using a byssus.

The most distinctive character is the length of the hinge ligament in relation to the breadth of the animal. In Fig. 1 the x-axis represents the breadth of the animal and the y-axis the length of the hinge ligament. The measurements plotted were all made on animals taken from bottom samples in which the two types occurred together. The bottom material was fine sand. In Fig. 1 the two types are clearly separated by the line $x = 3{\cdot}5\ y + 2$. Probably this function will prove to be invalid for the smaller animals, and perhaps the two types are separated by a non-linear function.

In geographical distribution the types are separated also, but they overlap in some localities. Such localities are the mouth of the Mariager Fjord estuary and the Kysing Fjord estuary, both situated at the Kattegat coast of Jutland. The animals used for Fig. 1 are from these localities, in which the salinity is always more than 20 per mille. In more brackish water, as, for example, the innermost parts of Mariager Fjord and Kysing Fjord and the estuaries on the Belt Sea and Baltic coasts, we find only *C. lamarcki*, which tolerates salinities from about 25 to about 5 per mille. *C. edule* does not tolerate salinities lower than 20 per mille. *C. exiguum* is found only in areas with a rather constant salinity about 7–14 per mille.

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Quantitative Gram-staining with Labelled Iodine

The development of a simple quantitative Gram-staining technique has been attempted by numerous observers[1,2], not only for its possible practical uses but also because of its potential value in studies on the mechanism of the staining reaction on intact cells and on extracellular material[3], as well as the relationship between degree of Gram-positivity and physiological state of the organisms. The recent procedure of Barbaro and Kennedy[4] is reasonably accurate but, since it involves measurement of dye nitrogen taken up by a suspension of organisms, it is rather laborious for practical application.

Taking advantage of the fact that iodine is co-operatively bound in the Gram reaction, we have developed a reasonably accurate quantitative Gram-staining technique based on the use of 'Lugol' solution labelled with iodine-131, followed by end-window counting of the stained smear on the slide. Our procedure is to stain a heat-fixed smear, containing about 8–13 μgm. dry mass of bacterial cells, according to the Hucker modification[5], the sole difference being that the 'Lugol' solution contains approximately 25 μc. iodine-131/ml. and is applied by means of a 20-μl. micropipette so as completely to cover the smear. Following are typical results

for 15-hr. cultures of several organisms (recalculated for 10 μgm. dry mass of each organism on the slide):

Strain	Degree of Gram-positivity (counts/min.)
Bacillus subtilis	2,856
Micrococcus lysodeikticus	1,320
Saccharomyces cerevisiae	1,068
Lactobacillus casei	883
Proteus vulgaris	245
B. coli	78

It will be noted that *Saccharomyces*, one of the most intensely Gram-positive organisms, is apparently less so than *B. subtilis* and *M. lysodeikticus*. This is, however, due to the variation of degree of Gram-positivity with age of culture and, especially, the decolorization technique used. If the decolorization step in the Gram procedure is increased by 1 min., then *Saccharomyces* show a higher count than other organisms.

The reproducibility of the method is about 5 per cent. The following modifications do not influence the final count: (1) two-fold increase in concentration of primary dye; (2) three-fold increase in concentration of the 'Lugol' solution, the specific activity/mgm. iodine being kept constant; (3) variation in time of application of the primary dye, or the 'Lugol' solution, from 15 sec. to 2 min. This is good evidence that the Gram-complex involves stoichiometric proportions of dye and iodine with some cell constituent(s). Decolorization of a stained smear until the count is almost zero, followed by re-staining, gives a count close to that of the original, so that the reaction is completely and quantitatively reversible. Treatment of a labelled smear with aqueous non-labelled 'Lugol' results in complete removal of radioactive iodine without altering the intensity of staining; subsequent application of aqueous labelled 'Lugol' restores the original count of the smear. In alcoholic 'Lugol' solution this exchange phenomenon does not occur. One may therefore conclude that the staining reaction involves co-operative binding of dye and ionic iodine. It is consequently doubtful whether dye fixation by Gram-positive cells is due to oxidation of cellular material by iodine[6]. The suggestion that iodotyrosine is formed upon application of the iodine[7] is rendered untenable by the rapidity with which the iodine in the Gram-complex is exchanged, for the rate of exchange of ionic iodine with the iodine in iodotyrosine is very low and is preceded by a pronounced lag period[8].

We have found the above technique extremely useful for various quantitative studies on Gram-staining, full details of which will be published elsewhere. We should like, however, to emphasize the considerable advantages to be gained from the general application of labelled substances to quantitative staining reactions as well as to the mechanisms of these reactions.

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Phototropism of *Phycomyces* Sporangiophores

The communication to *Nature* concerned with phototropism in *Phycomyces* from Curry and Gruen[1] and its extension by Carlile[2] may be considered in relation to the critical study of the phenomenon of adaptation undertaken by Delbrück and Reichardt[3].

The rate of growth of *Phycomyces* sporangiophores can be regarded as controlled by the supply of materials from the substratum mycelium, but it is influenced in the apical region by an unknown photo-sensitive system. The average growth-rate over a period of hours is independent of illumination, though it has a normal temperature coefficient: light favours earlier sporangium formation, but after that growth continues to an extent and for a duration not noticeably affected by visible light. Increase in intensity of symmetrical illumination with blue light leads, after two to three minutes, to a transient increase in the longitudinal growth-rate, Blaauw's[4] positive light-growth reaction. The rate may increase during the next few minutes to twice normal, then diminishes to less than normal even though the brighter illumination continues, and finally resumes its former rate with no net change in the average rate of growth. The sporangiophore has thus become adapted to a higher light flux. (In this respect its light-growth reaction differs from what appears to be usual in young green shoots.) Decrease in illumination produces a corresponding negative reaction and subsequent adaptation.

Phototropic curvatures arise when the rate of effective photon absorption in one side of the growing zone is appreciably different from that in the other side, leading to asymmetry in growth-rate. On a horizontal clinostat such curvatures continue for as long as spatial asymmetry in light absorption is maintained in the growing sporangiophores. This is quite compatible with the phenomenon of adaptation to changes in flux with time, for, while the distribution of growth-rate is not uniform, the average rate of growth in volume continues unchanged.

Curry and Gruen, remarking on the prompt reverse curvature when their cultures, unilaterally illuminated with ultra-violet light, were rotated through 180°, say that "this implies that there is little adaptation to the ultra-violet, the sensitivity remaining high through many such reversals of position". It may be that there is little adaptation, as could well be determined by observing whether the same intensity of response followed each time when a sporangiophore was first illuminated symmetrically with, say, 0·2 ergs/cm.²/sec. of ultra-violet radiation, and then at half-hour intervals the illumination was increased by successive equal increments of 0·2 erg/cm.²/sec. Without adaptation the same response would follow each time; with, it would diminish. Their conclusion is not, however, necessarily implied by prompt reversibility of the phototropic curvature. Adaptation can be regarded not only in relation to the sporangiophore as a whole but as a property varying in level throughout the growing region according to the light flux at each point. For a sporangiophore uniformly illuminated with blue light the flux throughout the apical zone will vary little. Under unilateral illumination with blue light there are, owing to the lens effect[5], rather more photons absorbed in the far half than in the near, so giving positive phototropism, but the gradient is not steep and the levels of adaptation do not greatly differ. Therefore

rotation through 180°, reversing this small flux gradient, results in only small changes in the growth-rates of the two sides (by redistribution of the materials being supplied from below) leading to a sluggish reversal of the positive phototropic curvature. When, however, the sporangiophores are illuminated either along one flank by a grazing pencil of light[6], or unilaterally under paraffin (refractive index, 1·47, giving a complete reversal of the lens effect), or are exposed to unilateral ultra-violet light of about 280 mμ wave-length (for which the absorption coefficient, α, is high), then there is a high rate of photon absorption on the illuminated side and a much lower rate on the other. With such marked differences in flux, and consequently in adaptive levels, rotation of the sporangiophore might be expected to lead to the sharp reversal of curvature found in these cases.

Turning now to the suggestion made by Carlile, it should be pointed out that, while it is true that the curve plotted by him shows a good approximation to the absorption spectrum of riboflavin, there is a danger of error in taking the phototropic curvature of a relatively transparent organ as an index of photodynamic effectiveness when determining the action spectrum. This is because the value of the absorption coefficient, α, changes with wave-length, thus changing the gradient of the corresponding photon absorption per unit volume. This, as Carlile suggests, presumably explains the change from positive to negative phototropism with diminishing wave-length in the ultra-violet.

If with ultra-violet radiation of 302 mμ wave-length there is a positive light-growth reaction in previously darkened sporangiophores, but not phototropic curvature because Castle's critical value for α is reached, then clearly the true action spectrum for a photo-response should not drop to zero as does the graph of angle of phototropic curvature that Carlile plots. A better curve for the primary photo-response could be obtained by the lengthy process of measuring the average light-growth response when passing suddenly from darkness to a standard flux of radiation of each of an extensive series of wave-lengths. With relatively transparent organs there is an inherent error when using either phototropic curvatures or null-deflexion methods with opposed sources of light of different wave-lengths as an index of photodynamic effectiveness. Add to this the probability of ineffective absorption in shadow-producing pigments, of which carotene may be one, and it is clear that great caution should be exercised when such results are compared with known absorption spectra.

Brauner[7] suggested that the positive light-growth reaction and phototropism in *Phycomyces* might arise through partial light-induced destruction of a previously supra-optional concentration of indolyl acetic acid. Results of experiments now in progress, some devised in discussion with him, do not seem to support this suggestion. Lanolin paste and sodium alginate gel containing 10 μgm. and 100 μgm./ml. of indolyl acetic acid have been applied with a micro-manipulator to one side of the growing zone of sporangiophores which either (1) had previously been subjected to intense illumination with blue light or (2) were, after indolyl acetic acid treatment, illuminated from the side opposite to that treated. Case (1) sporangiophores after further growth in red light having no phototropic action showed no significant response compared with controls treated with plain paste, and in case (2) the positive phototropic response was not reduced: these experiments need to be extended to cover a wider range of conditions.

Riboflavin may indeed be the photoreceptor in *Phycomyces*, and photo-absorption may either reduce the extent to which it checks indolyl acetic acid oxidation, or even directly promote this oxidation, but this assumption is not yet firmly grounded, and there is as yet no good evidence that internal indolyl acetic acid is a myco-auxin regulating the growth of chitin-walled hyphæ.

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The primary purpose of my previous communication[1] was to show that the reversal of phototropism at about 300 mμ reported by Curry and Gruen[2] is explicable in optical terms, and that it was not necessary to postulate a novel photochemical reaction occurring in the far ultra-violet. I also felt that it was useful to point out that Curry and Gruen's results on the relative effectiveness of different wave-lengths when plotted as an action spectrum give a curve similar to the absorption spectrum of riboflavin. I agree with Banbury as to the dangers inherent in this procedure, and realize that observations on the effectiveness of a range of wave-lengths in promoting the light-growth response would, if available, provide a better guide as to the nature of the photoreceptor substance.

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Limited Multiplication of *M. lepraemurium* in Tissue Culture

M. lepraemurium causes rat leprosy, which possesses many of the characteristics of the human disease. So far, attempts to culture the causative organism of either disease in bacteriological media or in tissue cultures have not provided convincing evidence of multiplication.

The minimum period required to maintain tissue cultures if the growth of *M. lepraemurium* is to be detected, can be inferred from the generation time *in vivo*. This was found to be 13 days[1,2]. Such relatively long periods of maintenance would result in a changing and variable cell population. On the other hand, since *M. lepraemurium* persists in a stainable form, the bacilli would, even without multiplication, become redistributed among the changing cell population. Previous methods for detecting multiplication, which have usually depended on the distribution of bacilli in tissue cells, are open to errors. To determine accurately, therefore,

whether multiplication has occurred, we have had to devise a method for counting the total number of bacilli per culture before and after cultivation.

The obligate intracellular existence of the bacillus within reticulo-endothelial type cells led us to use monocytes in our earlier attempts to culture *M. lepraemurium*, but no multiplication of bacilli was shown even after 80 days. However, bacilli recovered from some of these cultures were still infective[2].

We have now shown that multiplication of *M. lepraemurium* can occur in cultures of tissues obtained from previously infected animals. In a representative experiment the spleen was removed from a mouse infected intravenously 8 weeks previously with *M. lepraemurium* (Douglas strain[4]), and was cut, uniformly, into explants of 1 mm.[3]. The explants were pooled and put out in culture tubes (6 per tube) lined with plasma clot to which was added 1 ml. of medium containing 20 per cent horse serum, 5 per cent chick embryo extract and 75 per cent Hanks's balanced salt solution. Before incubation the tubes were randomized into two groups: (*A*) no addition of antileprous drugs, and (*B*) addition of 100γ streptomycin and 1γ isoniazid, a combination expected, from chemotherapeutic observations of rat leprosy[5,6], to inhibit growth of the organism *in vitro*, and so serve as an essential control. The tubes were incubated at 37° C. in roller drums, and the medium changed twice weekly (all medium kept for counting). After 24 hr. three tubes were picked at random from each group, each was trypsinized, the contents homogenized in a Ten Broeck grinder and the bacilli completely released from cells and dispersed by exposure to ultrasonic vibration. Using a modified Breed technique[7], a count was made of equivalent standard samples of homogenates from each culture. This procedure was repeated at 15 and 29 days, selecting the most healthy cultures. To increase the uniformity of the counting technique the homogenates, after immediate sampling, were stored until the experiment was completed and then, after further dispersal by ultrasonic vibration, new coded samples were prepared and counted again in one operation.

The counts are shown in Table 1. Each mean count of bacilli was obtained from three cultures, from each of which two spreads were made and counted in duplicate. The results show a highly significant increase ($P < 0{\cdot}001$) in the number of bacilli in cultures with no streptomycin or isoniazid, by the fifteenth day of incubation; no further increase occurred in cultures maintained for a further 14 days. There was no increase in the number of bacilli in cultures containing high concentrations of the drugs.

Under these conditions, and using precise methods to determine the total number of bacilli present in each culture, it has, therefore, been possible to demonstrate *in vitro* limited multiplication of *M. lepraemurium* in five experiments. Furthermore, the rate of multiplication *in vitro* corresponds closely to that observed *in vivo* in the mouse. In a personal communication from Dr. J. H. Hanks and his colleagues at Harvard Medical School, Boston, we have learned that substantially similar results have recently been obtained using explanted spleen cells from infected mice. Multiplication has been confined to the initial period of cultivation when the cell cultures are healthy. As soon as the infected cells begin to degenerate, increasing numbers of bacilli will be released and exposed to relatively high concentrations of serum, which have been shown to inhibit their endogenous metabolism[8]. It would seem, therefore, that continued multiplication *in vitro* of *M. lepraemurium* requires a regular supply of healthy cells, preferably in a medium containing low concentrations of serum. Methods for providing these cultural conditions are being investigated. A full account of this work will be published elsewhere.

Table 1. Mean Number of Acid-fast Bacilli counted in Standard Samples from Homogenized Cultures

	Group *A* cultures	Group *B* cultures
Streptomycin	None	100 γ/ml.
Isoniazid	None	1 γ/ml.
Days		
1	111·0	111·3
15	243·0	105·8
29	235·4	108·5

The 1 per cent limits for the ratio of the mean on day 15 to that on day 1 for group *A* cultures are 1·97 and 2·4. (Counts on the fluid changes were very low and are not included in the table.)

We wish to thank Dr. Ian Sutherland of the Medical Research Council's Statistical Research Unit for the statistical analyses.

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The Diatom *Asterionella* in the Krishna Estuary Region

During the course of an extensive hydrobiological survey of the Krishna River estuary, standing at the mouth of the northernmost branch of the Krishna River, we noticed that the shore waters and the sea, as far as the eye could see, were coloured deep chocolate brown, and that the intertidal sand was covered with a thick green scum. A sample of the water, taken one mile south of the river mouth, was collected in a bottle of known volume (2½ l.), fixed with formaldehyde and allowed to settle for a day, giving a sediment 30 ml. in volume. On analysis of the sediment by a conventional method (using a Sidgwick–Rafter cell), we found that it contained mainly swarms of diatoms, the majority of which belong to the chain-forming genus *Asterionella* (*Japonica ?*). Other forms like *Biddulphia*, *Thallassiothrix*, *Pleurosigma*, *Fragillaria*, and *Chaetoceros* were also found, but in fewer numbers. The catch represents a total population of 55·568 millions per litre (approximately 55·6 cells/mm.[3]). Of this *Asterionella* alone accounted for 51·6 cells/mm.[3].

The waters of the river emptying into the sea were very low both in salinity and phytoplankton content. The salinity was 0·305 per cent at the mouth of the river, but was as high as 2·69 per cent one mile south of the river mouth. Correspondingly, phytoplankton density also showed an enormous increase from 111 cells/ml. at the river mouth to 55·568 million cells/ml. one mile south of the mouth. In view of the fact that the coloured water contained a very dense

population of diatoms of which *Asterionella* accounted for nearly 93 per cent, it is reasonable to believe that the colour of the water was a result of the dense occurrence of *Asterionella*. But to our knowledge *Asterionella* was not previously known to be a causative factor in the production of coloured water.

Bainbridge[1], while considering observations concerning the size, shape and density of marine phytoplankton concentrations, quotes several figures for concentrations of diatoms, chiefly for normal waters, obtained by various workers from different regions. The highest figure he quotes, for *Asterionella*, is 3·6 cells/mm.[3] and observes that much higher figures of 31·6 cells/mm.[3] for other naturally occurring diatom densities, as was found by Marshall and Orr[2] in the waters of Loch Striven for 1927, must be considered localized and of limited duration. The densities found by us, when compared with the findings of other workers, referred to by Bainbridge, do not appear to be abnormal for highly coloured water with localized concentration of diatoms.

Such high densities in this particular region and the particular time are probably due to the enrichment of the area of the sea water, near the river mouth, by nutrient salts from the mainland through the agency of the flooded river during the north-west monsoon, which sets in during the latter half of June and continues until early October.

We wish to express our grateful thanks to Dr. Kandula Pampapathi Rao, Sri Venkateswara University, under whose general direction the hydrobiological survey is being carried out, and to Mr. Ch. Srinivasa Rao of Dintimeraka and his local associates for help and co-operation in collecting material.

V. S. R. Murthy
A. Venkataramaiah

Department of Zoology,
Sri Venkateswara University,
Tirupati, India. Sept. 13.

[1] Bainbridge, R., *Biol. Rev.*, **32**, 91 (1957).
[2] Marshall, S. M., and Orr, A. P., *J. Mar. Biol. Assoc. U.K.*, **16**, 853 (1930).

2,4-Dichlorophenoxyacetic Acid as an aid to Seed Production when widely separated *Solanum* Species are crossed

After repeated unsuccessful attempts to duplicate Swaminathan's[1] technique for overcoming the cross incompatibility between *Solanum* species, a study was undertaken to determine the causes of seed failure when widely separated *Solanum* species are crossed. This work showed that some pollen germinated in all attempted crosses between several tuber-bearing series of the genus. Apparently normal pollen tubes were even observed at the bases of *S. melongena* L. styles when that species was pollinated by *S. phureja* Juz. and Buk.

The work indicated that a failure in seed production following the crossing of widely separated *Solanum* species could be a result of a failure in fruit formation because too few seeds were present to stimulate growth of the ovary. Without fruit formation to provide the normal environment for development, the few seeds present would be unable to mature. Therefore, attempts were made to devise a method for stimulating ovarian development which would not itself inhibit seed formation. It was found that treating the ovaries 24 hr. after pollination with a drop of 3–6 p.p.m. of 2,4-dichlorophenoxyacetic acid (2,4-D) had the desired effect.

The results obtained from the cross of a diploid hybrid (*S. chacoense* Bitt. × *S. rybinii* Juz. and Buk.) × *S. stoloniferum* Schlecht., illustrate the value of the treatment. Several hundred attempted crosses of this parental combination yielded only three or four very small berries from the non-treated ovaries, whereas several hundred berries were produced by those treated with 2,4-dichlorophenoxyacetic acid. The berries from the non-treated fruit produced no seeds, but thousands of viable seeds were produced by the treated fruit. By means of this technique, viable seeds have also been obtained from several other wide crosses, and selfed seeds were obtained from hybrid clones of very low pollen fertility. Similarly, Fischnich and Lubbert[2] have reported that 2,4,5-trichlorophenoxyacetic acid was useful for producing seeds from difficult intervarietal crosses. However, these studies have shown that higher concentrations of the di- than of the tri-chlorophenoxyacetic acid were necessary to induce fruit formation in *Solanums*. Moreover, the indications were that the optimum concentration of the latter was sometimes inhibitory to seed formation. The full results of these investigations are being published elsewhere.

Leo A. Dionne

Field Crop Insect Section,
Entomology Laboratory,
Canada Department of Agriculture,
Fredericton, N.B.
June 4.

[1] Swaminathan, M. S., *Nature*, **176**, 887 (1955).
[2] Fischnich, O., and Lubbert, G., Plant Breeding Abstr., **23**, 95 (1953).

Colour Vision of Three Albinos

In 1951 an albino woman was given anomaloscope tests[1] and it was reported that she had a marked deviation in red vision. Recently, two albino men have been tested. The three subjects are unrelated. Tables 1 and 2 indicate th abnormalities of colour vision found in them on the anomaloscope[2].

Table 1. Red-Green Test

Subject's sex and age	Deviation	Matching range
f; 50	6 × sigma to red*	1 × mode*
m; 25	4 × sigma to red	5 × mode
m; 51	8 × sigma to red	5 × mode

* Both tests, about 3 weeks apart

Table 2. Yellow-Blue Test

Subject's age and sex	Deviation	Matching range
f; 50	2 × sigma to yellow	<1 × mode
	<1 × sigma to blue*	<4 × mode*
m; 25	1 × sigma to yellow	4 × mode
m; 51	zero	>2 × mode

* Second test, about 3 weeks later

It will be seen that all three albinos had red deviations almost equivalent to simple protanomaly, while the two men also had enlarged matching ranges, but not quite large enough for them to be classed as extreme protanomals. In none of them was the red end of the spectrum shortened. It is invariably shortened in extreme protanomalous but not invariably in simple protanomalous subjects.

In the yellow–blue test the two men had large matching ranges. The woman had no defect on her

first yellow–blue test except a small deviation to yellow, although she was more than fifty years of age; but on her second test she had an enlarged matching range and a very slight blue deviation.

The two men passed the Ishihara test, the younger making only one error. The elder made only four errors. He claimed to smoke seventy cigarettes a day. The woman, although she was less defective than the men, failed on the Ishihara test, with fifteen errors in twenty-four plates.

R. W. Pickford

Psychology Dept.,
The University,
Glasgow. Nov. 7.

[1] *Nature*, **168**, 954 (1951).
[2] *Brit. J. Physiol. Optics*, **14**, 2 (1957).

Moving Visual Images produced by Regular Stationary Patterns

It would seem that some of the intriguing visual phenomena discussed by Dr. MacKay[1] may be due, not to cerebral or retinal factors only, but at least in part to preretinal factors, namely, fluctuations of accommodation combined with lack of axial symmetry in the optical system of the eye. Helmholtz[2] described how, when looking at a pattern consisting of black and white concentric circles, and thus similar to one of Dr. MacKay's, a complicated system of darker and brighter radial zones is seen. If accommodation, or the distance from the pattern to the eye, is slightly altered, the positions of the brighter zones vary and the observer sees them rotate rapidly to and fro. According to the above explanation the phenomenon is due to actual changes occurring in the image of the pattern formed on the retina. Unless such changes can be ruled out as a factor in Dr. MacKay's more complicated experiments, it does not seem possible to conclude that subjective impressions of movement received while the pattern is looked at, or in afterimages, are necessarily caused by the nervous system responding to a truly stationary light distribution in the optical image formed by the eye.

M. H. Pirenne

University Laboratory of Physiology,
Oxford.

[1] MacKay, D. M., *Nature*, **180**, 849 (1957).
[2] Helmholtz, H. von, "Physiologische Optik", 1st ed., Part 1 (1856).

While viewing the pattern of concentric circles reproduced in *Nature* of October 26[1], many readers will have noted rapidly fluctuating sectors and they may have speculated about their cause.

This effect was first described by Helmholtz[2], but although he attributed it to accommodation, he did not give a definitive explanation of why the sectors appear to rotate.

When the young emmetrope focuses on a near test object the amount of accommodation exerted is not constant. The lens is constantly undergoing small (± 0·1 dioptre), rapid (2–3 c./s.) fluctuations of power. This has been demonstrated objectively with an infra-red high-speed recording optometer[3] (see Fig. 1). Arnulf *et al.*[4] have shown that these fluctuations are mainly astigmatic, that is, different segments of the circular ciliary muscle probably contract asynchronously. There are, therefore, even in the emmetropic eye, small, variable astigmatic errors that occur in constantly changing meridians. Inspection of Dr. MacKay's Fig. 2[1] clearly shows rotating sectors. The frequency of occurrence of the effect agrees with the objective measurements shown in Fig. 1 herewith. The reader can readily confirm that the cause of these rapidly rotating sectors is irregular fluctuations of accommodation. The rotation ceases if the eye is focused at infinity. This experiment may easily be done by viewing the pattern at 25 cm. or so through a +4 dioptre lens. Similarly, the rotation stops if the ciliary muscle is paralysed with homatropine eye drops. Naturally, the effect will not be reported by a presbyopic observer who is over the age of fifty-five years. The effect will also cease if the pattern is viewed through a 1-mm. artificial pupil, for the increased depth-of-focus of the eye eliminates the perception of the small variable astigmatic errors[5].

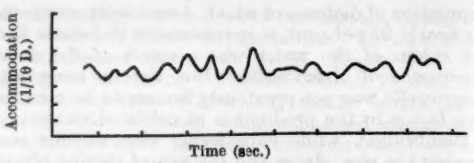

Fig. 1. Variation of power of accommodation measured in the vertical meridian of the eye during steady fixation of a small object (scale in 1/10 dioptre)

F. W. Campbell
J. G. Robson

Physiological Laboratory,
Cambridge.

[1] MacKay, D. M., *Nature*, **180**, 849 (1957).
[2] Helmholtz, H. von, "Handbook of Physiological Optics", 1, 192 (Optical Society of America translation) (1924).
[3] Campbell, F. W., *J. Physiol.*, **133**, 31*P* (1956).
[4] Arnulf, A., Dupuy, O., and Flamant, F., *C.R. Acad. Sci., Paris*, **232**, 349, 439 (1951).
[5] Campbell, F. W., *Optica Acta* (in the press).

The phenomenon mentioned by Dr. Pirenne is one of several side-effects of our patterns which are being separately investigated because they seem to be distinct from the complementary response. Helmholtz's "rotating sectors" are, of course, well known and may be considered as moiré fringes due to the superposition of displaced replicas of the pattern either in the optical image or at a neural level or both. In the 'ray' figure described in my previous communication[1] similarly fleeting 'figure of 8' moiré patterns can be seen as accommodation varies. The simplest way of demonstrating their origin is to cover the stimulus figure with a transparency of itself, when similar fringes appear (Fig. 1), and one can in fact measure the amplitude and direction of the effective retinal image-displacement by observing the displacement required in the transparency to produce the same moiré pattern.

The marked differences observed between these moiré patterns and the complementary images provided the first reason for believing that the latter had a different origin. The evidence[1,2] of interocular transfer, especially in random visual noise, and of the limited relevance of eye movement demonstrated by the persistence of the response with a stabilized retinal image and in stroboscopic light, combine to confirm that the complementary image presents a different and separable problem. Furthermore, following Campbell and Robson's helpful suggestion, I have verified that the complementary image is still seen when the ciliary muscle has been paralysed by homatropine. It can be seen also (by seven out of

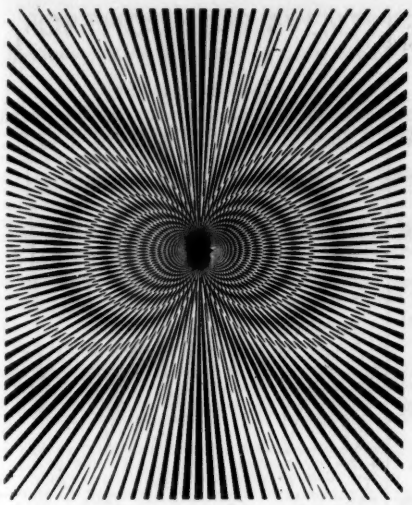

Fig. 1

ten observers to date) in the first few seconds after exposure of the ray-pattern in a single 120-Joule flash lasting less than $1\frac{1}{2}$ msec.

Finally, when the retinal image is deliberately moved in such a way that no moiré figures are generated (for example, by slightly rocking the ray figure about its centre several times per second), the complementary after-image is strengthened (presumably because 'on' and 'off' receptors are stimulated), whereas with other types of artificial motion it is not.

The foregoing evidence would appear to dispose also of a confusion in some early literature[3] between these complementary after-effects and the after-effects of seen movement, caused by the use of striped curtains and the like as moving stimuli. This work, to which my attention has been directed since my earlier communications were published, includes unmistakable reports of complementary images; but writers usually assimilate them to the 'streaming' after-image of movement which they were studying. If one uses a random dot pattern (for example, a photograph of sandpaper) as the moving stimulus, the two effects can be clearly separated.

One interesting side-effect which we are studying is an apparent disturbance of the accommodation reflex by the circular pattern. A hair laid obliquely across its central region may sometimes defy all efforts to bring it into sharp focus, although against a plain background at the same distance it becomes perfectly sharp. It is hoped that experiments in this connexion may yield some clues to the organization of the detector-system which normally enables an out-of-focus image to be corrected.

A fuller account of investigations using these regular stimulus-patterns will be published elsewhere.

D. M. MacKay

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Dec. 11.

[1] MacKay, D. M., *Nature*, **180**, 849 (1957).
[2] MacKay, D. M., *Nature*, **180**, 1145 (1957).
[3] See, for example, Hunter, W. S., *Psych. Rev.*, **22**, 479 (1915).

Coffinite in Cornwall

COFFINITE, $U(SiO_4)_{1-x}(OH)_{4x}$, a rare mineral previously reported only from the Colorado Plateau, United States[1], and the Buller Gorge area of South Island, New Zealand[2], has been identified in ore samples from Roskrow United Mine, Ponsanooth, Cornwall.

Here coffinite occurs as a replacement of colloform pitchblende. All stages of replacement occur from incipient alteration along radial fractures and concentric growth bands to complete colloform pseudomorphs measuring up to 5 mm. across.

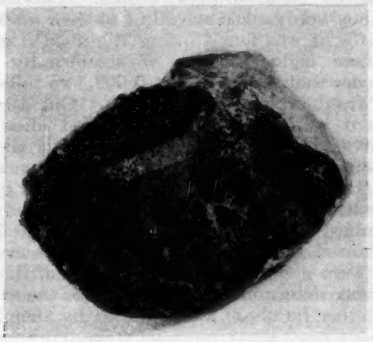

Fig. 1. Colloform aggregates of coffinite (black, lower part of specimen) pseudomorphous after pitchblende. × 0·85

The identification was based on X-ray powder photographs with the strongest lines at 3·49 (v.s.), 4·66 (s.), 2·64 (m.s.) and 1·80 (m.s.) A. A spectrographic analysis showed major uranium and silicon with vanadium and lanthanum among the minor elements.

A full description of the physical properties with a complete chemical analysis will be published elsewhere. The present communication is published by permission of the Director of the Geological Survey.

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Nov. 5.

[1] Stieff, L. R., Stern, T. W., and Sherwood, A. M., *Amer. Min.*, **41**, 675 (1956).
[2] Reed, J. J., and Claridge, G. G., *Nature*, **179**, 546 (1957).

Subjective Probability, Gambling and Intelligence

IT is well known that subjective ideas of probability differ from predictions made using statistical laws. This has been shown in temporal predictions by Jarvik[1], Cohen and Hansel[2] and others. It has also been shown by me[3] to be the case for predictions about spatial ordering.

It is also well known that persons in general like to gamble. If they have the choice of a number of different courses of action which, on the average, will yield the same benefit, they will prefer to risk some loss in order to chance some gain, rather than to choose a course which has a certain outcome. This preference has been shown in laboratory studies by Edwards[4].

The present communication is concerned with the relation between these two phenomena and intelligence.

I set persons the task of searching for an object which might be in one of a number of places, and related the strategy they adopted to their intelligence. This task could either be carried out systematically, or the person could gamble, he could work at 'random', pitting his confidence in his hunches against the risk of forgetting where he had looked. (The advantage of approaching this task systematically is that it ensures no moves will be forgotten.) Forty subjects were each given three problems; eighteen of them always worked systematically. When they were ranked according to their intelligence test scores, it was found (using Whitfield's[5] method) that these eighteen were of significantly higher intelligence than the rest ($p < 0.002$, two-tailed test).

The results posed a question. Did the more intelligent subjects have sophisticated ideas about subjective probability, or did they have the usual ideas but prefer to use the alternative, systematic, approach? In order to throw light on this question the results of my subjective probability study[3] were re-examined from the point of view of intelligence. This showed that intelligence and subjective probability were not related. It would seem, then, that intelligence determined not the hunches the man had, but whether he chose to be guided by them.

H. C. A. Dale

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[1] Jarvik, M. E., *Amer. Psychol.* (abstract), 1, 453 (1946).
[2] Cohen, J., and Hansel, C. E. M., *Brit. J. Psychol.*, 46, 178 (1955).
[3] Dale, H. C. A., M.R.C. App. Psychol. Res. Unit Report No. 280.
[4] Edwards, W., *Amer. J. Psychol.*, 66, 349 (1953).
[5] Whitfield, J. W., *Biometrika*, 34, 292 (1947).

Constant Temperature Water-Bath

A stationary manometric respirometer for the simultaneous measurement of oxygen consumption and contraction amplitude of electrically stimulated muscle preparations has been developed[1]. It is necessary to immerse this apparatus in a water-bath having a temperature control of ±0·01° C.

The most compact and efficient unit available ('Circotherm' unit with mercury contact thermometer No. 4110, 25–50° C. in 1/20th divisions. Shandon Scientific Co., Ltd., London), comprising heater, stirrer, thermometer and thermostatic control is found to give an accuracy of only ±0·023° C. under our experimental conditions. However, by including a 'Variac' continuously adjustable auto-transformer (Type *V6 HMT*. Zenith Electric Co., Ltd., London) in the above heater circuit the desired temperature control is easily obtained.

An unlagged 'Perspex' bath (0·32 m. × 0·25 m. × 0·25 m.) containing 20 l. of water is used: this stands on a metal frame in the laboratory at normal room temperature. By reducing the heater input voltage from 250 V. to 75 V. the temperature fluctuations are reduced from ±0·024° to ±0·001° C. in the centre of the bath (Fig. 1) and from ±0·016° to ±0·002° C. in the corner of the bath (Fig. 2). With 75 V. the absolute temperature differences between any two positions in the bath are ±0·006° C. (reducible by the use of lagging and additional stirring devices).

In practice the water-bath is brought to the required temperature with the 'Variac' giving full mains voltage. The voltage is then reduced to the working value of 75 V. The rate of stirring is unaffected. This system avoids the necessity for using both a booster heater and a smaller one.

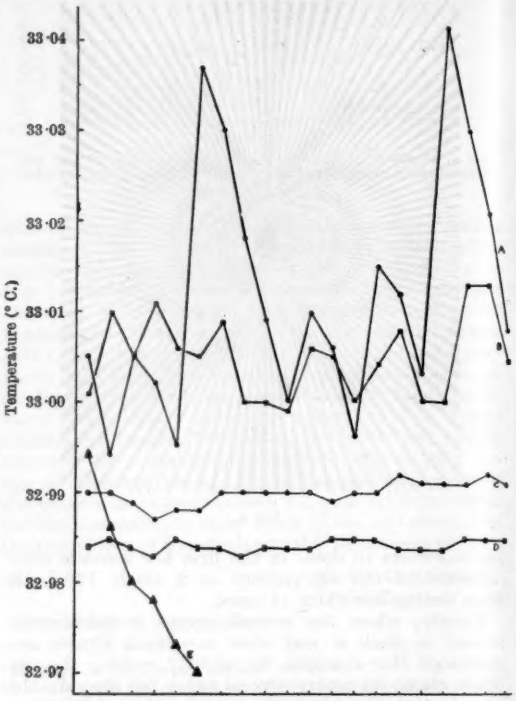

Fig. 1. Temperature fluctuations at centre of bath. *A*, 250 V.; *B*, 150 V.; *C*, 100 V.; *D*, 75 V.; *E*, 50 V.

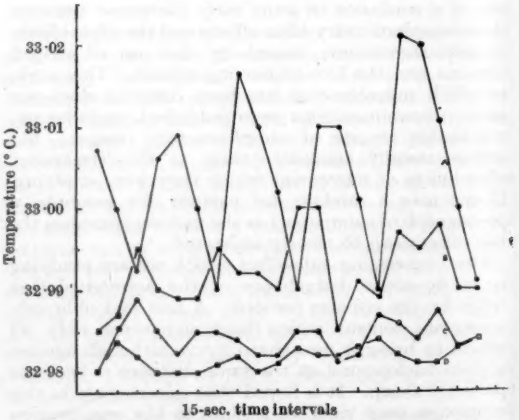

Fig. 2. Temperature fluctuations at corner of bath. *A*, 250 V.; *B*, 150 V.; *C*, 100 V.; *D*, 75 V.

A. Darbre
R. L. Speirs

Departments of Biochemistry
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King's College, London, W.C.2.
Oct. 30.

[1] Darbre, A., and Speirs, R. L., *Biochem. J.*, 67, 32 *P* (1957).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 3

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 5 p.m.—Mr. R. H. Franklin and Mr. M. B. Williams: "Recent Developments in Line Transmission Systems".

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Robert Clark: Presidential Address.

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the MICROBIOLOGICAL GROUP, at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. J. J. H. Hastings: "Microbiological Production of Organic Chemicals".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Mr. John Ward Perkins: "The Ancient Landscape of Southern Etruria".

Tuesday, February 4

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (at 14 Belgrave Square, London, S.W.1), at 10.30 a.m.—Nitrogen Meeting.

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Scientific Papers.

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. N. E. V. Viner-Brady and Mr. H. M. Pearson: "The Use of Aerial Photography by Railways".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT AND CONTROL SECTION (in conjunction with the BRITISH NUCLEAR ENERGY CONFERENCE, at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. J. H. Bowen and Mr. E. F. O. Masters: "Temperature Transients in Gas-Cooled Thermal Nuclear Reactors"; Mr. W. Abson, Mr. P. G. Salmon and Mr. S. Pyrah: "Boron-Trifluoride Proportional Counters" and "The Design, Performance and Use of Fission Counters"; Dr. J. Howlett: "The Application of Digital Computers to Nuclear-Reactor Design".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.30 p.m.—Prof. J. Z. Young, F.R.S.: "The Living Body as a Machine". (Further lectures on February 5, 11 and 12. Lectures for Sixth Form Boys and Girls from Schools in London and the Home Counties.)

SOCIETY OF DYERS AND COLOURISTS, LONDON SECTION (joint meeting with the LONDON SECTION of the TEXTILE INSTITUTE, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Dr. T. Vickerstaff: "Progress in Textiles. A review of developments and their effect on industry and user: Dyeing and Finishing".

Wednesday, February 5

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Discussion on "Experimental Results with the Zeta Apparatus on Controlled Thermonuclear Reactions" opened by Sir John Cockcroft, F.R.S.

ROYAL SOCIETY OF MEDICINE, HISTORY OF MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5.15 p.m.—Sir Weldon Dalrymple-Champneys: "Preventive and Curative Medicine in Ancient Peru" (Presidential Address).

INSTITUTE OF PETROLEUM (at 61 New Cavendish Street, London, W.1), at 5.30 p.m.—Dr. P. J. V. Agius and Mr. D. Mulvey: "Mechanism of Sludge Suspension in Engine Oil".

ROYAL SOCIETY OF MEDICINE, EXPERIMENTAL MEDICINE AND THERAPEUTICS SECTION (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Symposium on "Hæmoglobin". Speakers: Prof. C. Rimington, Dr. A. C. Allison, Dr. H. V. Ingram and Dr. J. Walters.

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Dr. W. J. G. Beynon: "Radio Investigations during the I.G.Y.".

Thursday, February 6

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1) at 4.30 p.m.—Mr. S. A. Kitchener and Mr. R. F. Strickland-Constable: "Growth and Evaporation of Crystals from the Vapour Phase"; Mr. R. Hide: "An Experimental Study of Thermal Convection in a Rotating Liquid".

UNIVERSITY OF LONDON (at the Middlesex Hospital Medical School, Mortimer Street, London, W.1), at 5 p.m.—Prof. T. S. Westoll, F.R.S.: "Pattern and Form in the Vertebrate Skull: a Study in Plastic Deformation and Its Limits".*

BEDFORD COLLEGE (at Regent's Park, London, N.W.1), at 5.15 p.m.—Prof. J. Z. Young, F.R.S.: "The Brain and Its Connections".*

INSTITUTE OF REFRIGERATION (at the Junior Institution of Engineers, Pepys House, 14 Rochester Row, Westminster, London, S.W.1), at 5.30 p.m.—Dr. Audrey U. Smith: "The Preservation of Living Cells and Tissues at Low Temperatures".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. H. W. Melville, F.R.S.: "High Polymers" (Forty-ninth Kelvin Lecture).

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. Colin Clark: "World Population".* (First of the Newmarch Lectures in Economic Statistics. Further Lectures on February 13, 20 and 27.)

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 17 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. B. R. T. Frost: "Corrosion by Liquid Metals".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with the KINGSTON TECHNICAL COLLEGE CHEMICAL SOCIETY, at Kingston Technical College, Fassett Road, Kingston), at 7 p.m.—Prof. H. J. Emeléus, F.R.S.: "The Boron Hydrides and their Potential Uses".

Friday, February 7

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (joint meeting with the INSTITUTION OF HIGHWAY ENGINEERS, at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 5.30 p.m.—Dr. E. K. Woodford, Mr. R. C. B. Gardner and Mrs. M. W. Spitta: "Planting and Control of Road Verges".

SOCIETY OF DYERS AND COLOURISTS, LONDON SECTION (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Mr. C. C. Wilcock: "Spun-dyed Fibres, their Properties and Uses".

SOCIETY FOR ANALYTICAL CHEMISTRY, MICROCHEMISTRY GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Annual General Meeting, 6.30 p.m.—Ordinary Meeting of the Society organized by the Microchemistry Group.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. John Marco Allegro: "The Dead Sea Scrolls".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ANALYST (with a B.Sc. degree, preferably with honours in organic chemistry, and an interest in biochemistry and animal nutrition research) IN THE NUTRITION RESEARCH LABORATORY, Department of Agriculture, Glenfield, N.S.W., Australia, for duties which include the supervision and testing of analytical procedures in biological chemistry (vitamin A blood ketone assays, etc.) involving techniques such as paper chromatography and spectrophotometry—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (February 12).

READER IN CHEMICAL ENGINEERING; READER IN ELECTRICAL ENGINEERING (Heavy Current); READER IN MECHANICAL ENGINEERING; READER IN PHYSICAL METALLURGY, READER IN INDUSTRIAL METALLURGY; READER IN MATHEMATICS or MATHEMATICAL PHYSICS—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (February 12).

RESEARCH STUDENT (with a good honours degree in engineering or science) IN BIOMECHANICS—The Registrar, King's College, Strand, London, W.C.2 (February 14).

ASSISTANT LECTURER IN GENETICS—The Registrar, The University, Sheffield (February 15).

ASSISTANT LECTURER (with an honours degree in psychology and additional training or experience in clinical psychology) IN CLINICAL PSYCHOLOGY in the Department of Psychiatry of the Faculty of Medicine—The Registrar, The University, Manchester (February 15).

INTERNATIONAL PAINTS RESEARCH FELLOW (preferably with at least two years postgraduate research experience) at the Plymouth Laboratory, to continue biological and chemical research already in progress, including research with radioactive substances, with a view to furthering knowledge of the effect of toxic substances on marine animals and plants—The Secretary, Marine Biological Association, The Laboratory, Citadel Hill, Plymouth, Devon (February 15).

TECHNICIAN (preferably with experience in workshop practice or histological techniques) AT THE MARINE BIOLOGY STATION—The Registrar, University College of North Wales, Bangor, North Wales (February 15).

ASSISTANT LECTURER (with qualifications in either pure or applied mathematics) IN MATHEMATICS—The Registrar, The University, Manchester 13 (February 17).

PRINCIPAL LECTURER (with high qualifications in physiology and preferably some experience as a university lecturer) IN ANATOMY AND PHYSIOLOGY—The Principal, Loughborough Training College, Loughborough (February 21).

SENIOR LECTURER IN ZOOLOGY at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 21).

ASSISTANT LECTURER or LECTURER IN GEOLOGY—The Secretary, The University, Exeter (February 22).

RESEARCH FELLOWS (Ph.D., with a special aptitude for research in high or low energy nuclear physics) IN EXPERIMENTAL or THEORETICAL NUCLEAR PHYSICS—The Registrar, The University, Liverpool (February 22).

LECTURER or ASSISTANT LECTURER (honours graduate, preferably with research interests in mycology and plant pathology) IN BOTANY at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (February 25).

LECTURER IN BIOCHEMISTRY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 28).

PROFESSOR OF PURE MATHEMATICS in the Durham Division of the University—The Registrar, University Office, 46 North Bailey, Durham (March 1).

HEAD (with an honours or higher degree in science with extensive experience of teaching, advisory work and research in agriculture and dairy bacteriology) OF THE COLLEGE DEPARTMENT OF BACTERIOLOGY—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (March 15).

RESEARCH ASSISTANTS (2) (theoretical physicists with research experience) IN THE DEPARTMENT OF THEORETICAL PHYSICS, for special research into fundamental particle and nuclear physics—The Registrar, The University, Liverpool (March 15).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS IN BIOCHEMISTRY, CHEMISTRY, CHEMOTHERAPY, ENGINEERING, METALLURGY, PHARMACOLOGY AND PHYSICS—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

Turner and Newall Research Fellow in Engineering, Inorganic Chemistry or Physics—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

Analyst (with a university degree in chemistry or equivalent qualification in analytical chemistry, for example, A.R.I.C., with two years research experience in pure or applied chemistry) in the Department of Agriculture, Federation of Nigeria, to carry out analysis and testing of soils and plant materials in connexion with the research programme of a soils and crop nutrition team, and to supervise the routine work in the chemistry laboratory—The Director of Recruitment, Colonial Office, London, S.W.1, quoting Ref. BCD. 63/14/037.

Hospital Biochemist, Basic grade (with a B.Sc. degree, with chemistry or biochemistry as main subject or equivalent qualification)—The Chief Pathologist, West Middlesex Hospital, Isleworth, Mddx.

Laboratory Technician (preferably with experience in photography or vacuum techniques) in the Department of Physics, Washington Singer Laboratories, for duties which will include the care and maintenance of laboratories—The Secretary, The University, Exeter.

Lecturer, Assistant Professor, Postdoctorate Fellow, and a Research Assistant in the Department of Physics—Head of the Department of Physics, University of British Columbia, Vancouver, B.C., Canada.

Lecturer (Grade IIa) in each of the following Departments: Mechanical Engineering Department, Physics Department and the Chemistry Department—The Principal, Paisley Technical College, George Street, Paisley.

Physical Chemist, Scientific or Senior Scientific Officer grade (with postgraduate research experience in reaction kinetics, particularly oxidation work), at the Wantage Radiation Laboratory, to work on the development of industrially important reactions initiated by radiation—The Recruitment Officer (1018.Z/34), Atomic Energy Research Establishment, Harwell, Didcot, Berks.

Research Officer (with a university degree in forestry or a university degree in botany and a diploma in forestry) in the Department of Forest Research, Federation of Nigeria, to carry out silvicultural investigations, chiefly in the high forest regions of the Federation, but with a possibility of work in the savannah regions also—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.61/14/06.

Research Student in Physics in the field of microwave spectroscopy of solids, particularly at low temperatures—The Registrar, The University, Nottingham.

Scientific Officers (with a first- or second-class honours degree in an appropriate subject or equivalent) with the Ministry of Supply at research and development establishments, mainly in the south of England, for work in physics, electronics, electrical, mechanical or aeronautical engineering, applied mathematics, metallurgy or chemistry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.8/8A.

Senior Geologist (with a degree in geology and not less than ten years experience in geology, including water geology and drilling) in the Water Development Department, Government of Cyprus, to take charge of the drilling section of the Department, which includes geology, and to carry out miscellaneous geophysical and other research work, and to work in close collaboration with the Hydrological Section of the Water Development Department—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.140/17/06/T.

Senior Physicist to take mainly sixth form work including university scholarship level; and a Physicist to teach throughout the school to the advanced level standard if necessary—The Warden, Trinity College, Glenalmond, Perthshire.

Senior Scientific Officer or Scientific Officer (Thermodynamics) (with a first- or second-class honours degree and a knowledge of current and future developments in aircraft and missile propulsion systems) with the Air Ministry, for work concerned with deducing performance characteristics of propulsion systems of the world's latest types of aircraft and missiles, and involves personal liaison with Fighting Services Experimental Establishments and firms in the U.K. and the United States—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.21/8A.

Senior Technologist (with a university honours degree in science, applied science or chemical engineering, together with some postgraduate research experience) with the Bread Research Institute of Australia, to initiate and expand investigations into the physical properties associated with the mechanical manipulation of dough, the high and low temperature storage of bread, temperature and humidity factors in oven performance—The Director, Bread Research Institute of Australia, 111 Pacific Highway, North Sydney, N.S.W., Australia.

Specialist Officer (Statistician) (with a good honours degree in mathematics and two years postgraduate experience in statistics as applied to agricultural research) with the Federation of Nigeria, for duties which will include the building up and supervising of a statistics branch in the Department of Agricultural Research—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/14/048.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Forestry Commission. Forest Record No. 35: The Use of Home-Grown Timber in Packaging and Materials Handling. By J. R. Aaron. Pp. 32. (London: H.M. Stationery Office, 1957.) 2s. 6d. net. [1211

Statement by the Forestry Commission of Great Britain prepared for the British Commonwealth Forestry Conference, 1957. Pp. 24. (London: Forestry Commission, 1957.) [1211

Department of Scientific and Industrial Research. Road Research Laboratory. Road Research Technical Paper No. 38: Some Safety Aspects of Pedal and Motor-Assisted Cycles. By Dr. H. J. H. Starks and R. D. Lister. Pp. iv+40+4 plates. (London: H.M. Stationery Office, 1957.) 2s. 9d. net. [1211

The Life and Work of Frederick Winslow Taylor. Pp. ii+17. (London: Urwick, Orr and Partners, Ltd., 1957.) 2s. 6d. [1211

Building Research Station Digest, October 1957: Plastics for Building. Pp. 8. (London: H.M. Stationery Office, 1957.) 3d. net. [1211

Journal of the West African Science Association, Vol. 1, No. 1 (October, 1954). Pp. 72. (London: Charles Knight and Co., Ltd., 1954. Published for the West African Science Association.) 12s. 6d. [1211

Glasshouse Crops Research Institute. Annual Report, 1954–1955. Pp. 108+6 plates. (Littlehampton: Glasshouse Crops Research Institute, 1957.) [1211

Tube Investments Limited. Chairman's Statement—Annual General Meeting, Birmingham, 9th December, 1957. Pp. 12. (London: Tube Investments Limited, 1957.) [1211

Library Association. Special Subject List No. 22: Vintage Cars. Pp. 18. (London: Library Association, 1957.) 2s. 6d. [1811

National Physical Laboratory. MSF—Standard Frequency Transmissions from the United Kingdom. Pp. 7. (Teddington, Mddx.: National Physical Laboratory, 1957.) [1811

The Leverhulme Trust. Leverhulme Research Awards: First Report. Pp. 72. (London: The Leverhulme Trust, 1957.) [1811

Memoirs of the Royal Astronomical Society. Vol. 68, Part 1: Radial Velocities of Southern B Stars Determined at the Radcliffe Observatory (Paper 2). By M. W. Feast, A. D. Thackeray and A. J. Wesselink. Pp. 35. (London: Royal Astronomical Society, 1957.) 16s. [1811

British Iron and Steel Research Association. Survey, 1957. Pp. 16. (London: British Iron and Steel Research Association, 1957.) [1811

Imperial College of Science and Technology (University of London). Research Report of the Royal School of Mines, 1954–57. Pp. vi+46+10 Plates. (London: Imperial College of Science and Technology, 1957.) [1811

Other Countries

Illinois Natural History Survey Bulletin. Vol. 27, Article 1 (August 1957): Ecological Life History of the Warmouth (Centrarchidae). By R. Weldon Larimore. Pp. 83. (Urbana, Ill.: Department of Registration and Education, Natural History Survey Division, 1957.) [1211

Fisheries Research Board of Canada. Bulletin No. 111: Report of the Atlantic Herring Investigation Committee. By A. H. Leim, S. N. Tibbo, L. R. Day, L. Lauzier, R. W. Trites, H. B. Hachey and W. B. Bailey. Pp. viii+317. (Ottawa: Fisheries Research Board of Canada, 1957.) [1211

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 38 (September 1957): Sex Difference in Mortality Increasing. Longevity of Industrial Population at New High. Geographic Variation in Fatal Accidents. Recent Progress in Control of Maternal Mortality. Pp. 12. (New York: Metropolitan Life Insurance Company, 1957.) [1211

Colony of Mauritius. Meteorological Observations and Climatological Summaries, 1956. Part 7: July, 1956. Pp. 12. Part 8: August, 1956. Pp. 12. Part 9: September, 1956. Pp. 12. Part 10: October, 1956. Pp. 12. Part 11: November, 1956. Pp. 12. Part 12: December, 1956. Pp. 12. (Port Louis: Government Printer, 1957.) [1211

Sveriges Geologiska Undersökning. Avhandlingar och Uppsatser. Series C, No. 539: Skredet vid Intagan ar 1648. Av Björn Järnefors. Pp. 18+2 plates. 2 kronor. Series C, No. 541: Nya Geologiska Undersökningar vid utö Järnmalmsfält. Av Nikolaj Pilava-Podgurski. Pp. 54. 3 kronor. Series C, No. 542: On the Occurrence of Ignimbrite in the Pre-Cambrian. By S. Hjelmqvist. Pp. 12+12 figures. 1 kronor. Series C, No. 543: Ein Beitrag zur Stratigraphie und dem Bau des Skelleftefeldes, Nordschweden. Von Gunnar Lautsky. Pp. 65+4 plates. 6 kronor. Series C, No. 544: Petrology of the Uppsala Region, Eastern Sweden. By P. H. Lundegårdh. Pp. 74+1 plate. 6 kronor. Series C, No. 545: An Earthquake Catalogue for Fennoscandia for the years 1891–1950. By Markus Båth. Pp. 52. 3 kronor. Series C, No. 546: De Glasiga Diabasgångarna i Djupviks Kalkbrott, Björkviks Socken, Södermanland. Ac Erik Åhman. Pp. 18. 2 kronor. Series C, No. 547: On the Stratigraphical Value of the Megaspores of *Lycostrobus scottii*: Preliminary Report of Some New Finds and Their Interpretation. By Britta Lundblad. Pp. 11+1 plate. 1 kronor. Series C, No. 548: A Petrological Investigation on Lake Norra Dellen by Means of Frog-Man Equipment. By Leonardo L. Redaelli. Pp. 22. 2 kronor. Series C, No. 551: Geokronologiska Undersökningar i Värmland. Av Jan Lundqvist. Pp. 28+1 plate. 2.50 kronor. Series C, No. 554: C14-Dateringar am Rekurrensytor i Värmland. Av Jan Lundqvist. Pp. 22. 2 kronor. Series C, No. 557: C14-Analyser i Svensk Kvartärgeologi, 1955–57. Av G. Lundqvist. Pp. 25. 2 kronor. Årsberättelse för År 1954. Pp. 8. Årsberättelse för År 1955. Pp. 9. Årsberättelse för År 1956. Pp. 8. (Stockholm: Kungl. Boktryckeriet P. A. Norstedt & Söner, 1956 and 1957.) [1811

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Applications are invited from British students for scholarships offered by Austria, Belgium, Brazil, Denmark, Finland, France, Germany, Iceland, Iran, Italy, Japan, The Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, and Yugoslavia. The awards are mainly for university graduates and undergraduates and are tenable for periods varying from a few weeks to twelve months during the academic year 1958-59.

Full particulars and application forms, for which a stamped (3d.) self-addressed adhesive label should be sent, are obtainable from the British Council, 65 Davies Street, London, W.1, or from any British Council office in the United Kingdom.

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Applications, with curriculum vitae, to Dr. J. H. Burgoyne, Department of Chemical Engineering, Imperial College, S.W.7.

GRADUATE RESEARCH SCHOLARSHIPS

DEPARTMENT OF BIOLOGY, McMASTER UNIVERSITY

Applications for Graduate Research Scholarships are invited from qualified students wishing to work towards the M.Sc. and Ph.D. degrees. The minimum annual stipend for a twelve-month period is $1,500. Research in progress: Ecology and physiology of aquatic and bloodsucking insects; population dynamics of grasshoppers (D. M. Davies). Formation of lake bottom sediments; sensory physiology in fish (H. Kleerekoper). Viruses in wild plants; cytological studies (W. D. MacClement). Physiology of yeast sporulation; ecology of soil microflora (J. J. Miller). Experimental embryogeny; organic terrain organization; palaeobotany and evelopmental morphology; applied palaeobotany and palynology (N. W. Radforth).

Applications should be sent before March 15, 1958, accompanied by university transcript and letters of recommendation from two professors, to Dr. H. Kleerekoper, Chairman, Department of Biology, Hamilton College, McMaster University, Hamilton, Ontario, Canada.

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A Tutorial Research Studentship in Mathematics (Pure or Applied) is offered for the session 1958-59, renewable for a second year. The Studentship is intended to enable the holder, while gaining some experience of university teaching, to work for a higher degree of the University of London or some other university. Value £350 a year, or £170 with board and residence.

Particulars may be obtained from the Principal, Royal Holloway College, Englefield Green, Surrey, to whom applications should be sent not later than March 1, 1958.

NUFFIELD FOUNDATION

BIOLOGICAL SCHOLARSHIPS AND BURSARIES

The Nuffield Foundation, as part of its programme for the advancement of biological studies, is prepared to offer for the academic year 1958-9 a limited number of Scholarships and Bursaries to enable persons who have graduated in physics, chemistry, mathematics or engineering, but who have had no training in a biological subject, to receive such training in biology as will enable them in due course to undertake research and teaching in the United Kingdom in the biological sciences. The Scholarships, which are senior awards, are intended for persons who have already undertaken some postgraduate research in their own subject. The Bursaries are intended to enable those who have recently graduated to complete a course of training in biological subjects including, if considered necessary, a full honours degree course in biology. In the case of both scholars and bursars the Foundation will pay the cost of university and/or college fees in addition to a maintenance award. Graduates of Universities in the United Kingdom, of either sex and preferably between the ages of 22 and 35, are eligible to apply.

Applications for awards in 1958 must be received before April 1, 1958, by the Director, The Nuffield Foundation, Nuffield Lodge, Regent's Park, London, N.W.1, from whom full particulars and application forms can be obtained.

L. FARRER-BROWN,
Director of the Nuffield Foundation.

NUFFIELD FOUNDATION

SOCIOLOGICAL SCHOLARSHIPS AND BURSARIES

The Nuffield Foundation, in pursuance of its programme for the advancement of sociological studies, is prepared to offer for the academic year 1958-9 a small number of Scholarships and Bursaries to enable graduates in academic subjects other than the social sciences, psychology or economics, to study the social sciences. The Foundation's particular object is to enable men or women, who are already well qualified in other disciplines, particularly the natural sciences or humanities, to receive a training in, for example, political science, social psychology, anthropology, socal statistics and sociology generally (but not economics) so that in due course they may undertake research or teaching in the United Kingdom in these subjects. The Scholarships, which are the senior awards, are intended for persons who have already undertaken some postgraduate work in their own subject. The Bursaries are intended to enable those who have recently graduated to take a course of training in sociological subjects. In the case of both scholars and bursars the Foundation will pay the cost of university and/or college fees in addition to a maintenance award. Graduates of Universities in the United Kingdom, of either sex and preferably between the ages of 22 and 35, are eligible to apply.

Applications for awards in 1958 must be received before May 1, 1958, by the Director, The Nuffield Foundation, Nuffield Lodge, Regent's Park, London, N.W.1, from whom full particulars and application forms can be obtained.

L. FARRER-BROWN,
Director of the Nuffield Foundation.

RESEARCH SCHOLARSHIPS AT THE INSTITUTE OF CANCER RESEARCH: The Royal Marsden Hospital invites applications from graduates with special interest in the chemistry and biochemistry of the nucleic acids. The work will be carried out under the supervision of Dr. K. S. Kirby, and the successful candidate will be encouraged to proceed to a higher degree.—The post is tenable at the Pollards Wood Research Station of the Institute of Cancer Research, Royal Cancer Hospital, Nightingales Lane, Chalfont St. Giles, Bucks, and applications should be sent direct to Dr. Kirby at this address not later than February 28, 1958.

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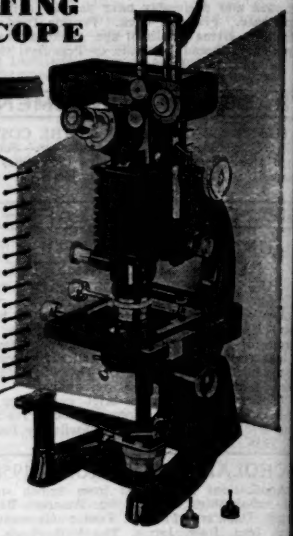

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